SPACE SOLAR POWER MULTI-BODY DYNAMICS AND CONTROLS, CONCEPTS FOR THE INTEGRATED SYMMETRICAL CONCENTRATOR CONFIGURATION

FINAL REPORT

Prepared By
John R. Glaese
and
Emmett J. McDonald

bd Systems, Inc.
600 Boulevard South, Suite 304
Huntsville, Alabama 35802

Sponsored By:

GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Under:

Contract No. NAS8-00151

December 29, 2000

Table of Contents

Bd Systems®
TCD20000222A
29 December 2000

Contract No.
NAS8-00151
Final Report

Space Solar Power Multi-Body Dynamics and Controls, Concepts for the Integrated Symmetrical Concentrator Configuration Final Report Contract NAS8-00151

1.0 INTRODUCTION

Orbiting space solar power systems are currently being investigated for possible flight in the time frame of 2015-2020 and later. Such space solar power (SSP) satellites must be extremely large to make practical the process of collection, microwave conversion, and reconversion to electrical power at an earth station or at a remote location in space. Many different configurations have been proposed by various study groups over several years of study. We will not review these concepts but instead, will concentrate on the one which has been defined to be our focus for this study, the Integrated Symmetrical Concentrator (ISC). The Integrated Symmetrical Concentrator (ISC) is composed of two very large, segmented reflectors, shaped like clamshells. Each reflector is a flat mirror and each clamshell contains 36 such reflectors. These are individually mounted and aimed to concentrate the reflected sunlight onto two centrally located photovoltaic arrays. The sunlight is converted to electrical energy and transmitted by cabling to a large transmitter, which in turn converts the electrical energy to RF energy and beams it to a dedicated rectenna site on Earth. The transmitter is suspended between the two PV arrays, providing an adequate view of space from the back of the transmitter to manage the thermal loads. The metering structure, which maintains the positions of the clamshell

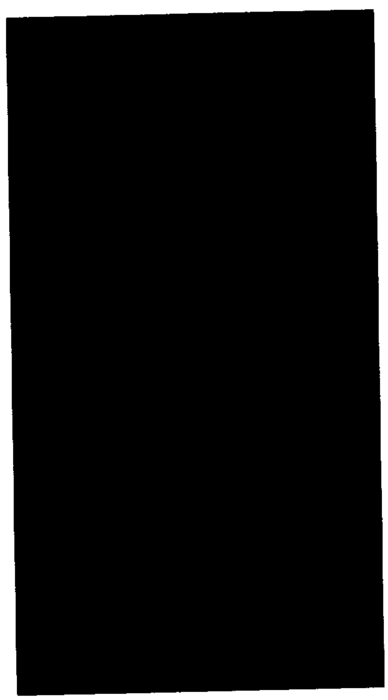


Figure 1.0.1 Artist concept of Integrated Symmetrical Concentrator, courtesy of NASA.

reflectors, is a long, flexible beam aligned with the orbit normal. Bearings and drives at each end rotate the clamshells to track the sun throughout the orbit, and tip them for beta tracking. The ISC is to operate in geosynchronous equatorial orbit. An artist sketch of the ISC configuration is shown in figure 1.0.1. The expected power output from the radiating antenna at GEO will be approximately 2 gigawatts. With conversion and radiation losses this is expected to result in 1.2 gigawatts at the output of the earth station. From this discussion it is evident that the operating attitude of the ISC satellite is to be perpendicular-to-the-orbit-plane, the POP attitude. The sunlight collector sections must point toward the sun and since the

sun motion relative to the earth completes one revolution in a year, the collectors must rotate approximately one degree per day. In addition, they also are tracking the sun's northerly and southerly excursions of +/- 23.5° per year relative to the equatorial plane. Meanwhile, the radiator section must track the earth station location, rotating once around per day. For purposes of these studies, the earth station is assumed to be a point on the earth's equator. Any earth station latitudes other than zero are to be reached by use of electronic beam steering. All power conversion for the ISC configuration is envisioned to occur at the center section in order to minimize the requirement for cabling and power transfer from one section to another. From this discussion, it is clear that the concentrators must be hinged relative to the center section to accommodate these different rotational motions. Two concentrators are provided for symmetry and must be sufficiently separated from the center section for proper focus. The boom is required to position the clamshells, maintaining their focus and providing support. The clamshells are umbrella shaped structures which reflect the sunlight onto photovoltaic arrays near the center of the ISC. The clamshell normal unit vectors bisect the angles between the sun line of sight vector and the orbit normal vectors. This is required to keep the sunlight directed onto the PV arrays. The planes of the PV arrays are not perpendicular to the boom but are rotated 20 degrees so that they have a sufficient view of deep space for proper thermal radiative cooling. The entire central section called the central body in the following, rotates once per orbit (one orbit = one day, 24 hours) maintaining the power beam pointed at the earth station and carrying the PV arrays along with it. The boom structure rotates with the central body in all control concepts except concept 1. In concept 1 there is a single relative degree of rotational freedom about the central body's Z axis. All control concepts 1, 2A, 2B, and 3 will be described in more detail in later sections of this report.

1.1 STATEMENT OF WORK

The National Aeronautics and Space Administration notified bd Systems in April of 2000 that our NRA8-23 proposal number PL90059A entitled "Multi Body Dynamics & Controls", submitted May 12, 1999 was selected for funding with a reduced scope. Specifically, tasks 2 and 4 from that proposal were selected. Task 2 calls for the Analysis of a sample problem to be provided by NASA and Task 4 for documentation. For purposes of this study, the sample problem of interest to NASA is the dynamics and control of the Integrated Symmetrical Concentrator configuration described in the following paragraph:

An understanding of the on-orbit dynamics of this configuration is necessary for concept feasibility assessment, the preliminary design of an attitude control system and an estimate of stationkeeping requirements. The sample problem dynamics and controls studies have been worked according to the subtasks below:

1.1.1 Subtask 1 – Dynamics Model Development

Develop a dynamics model of the Integrated Symmetrical Concentrator in geosynchronous orbit. A minimum model would consist of two rigid bodies representing the clamshells that track the sun, attached by flexible beams to a central rigid body that tracks a fixed point on Earth. Quantify the pertinent disturbance torques and forces (gravity gradient, solar radiation pressure, gyroscopic, etc).

1.1.2 Subtask 2 – Attitude Control Concept

Propose an attitude control system concept that will maintain clamshell solar tracking and transmitter array tracking of the rectenna-site on Earth. Perform trades on centralized vs. distributed or hybrid control architectures. For the 1.2 GW configuration to be built after 2020, develop estimates of torque/momentum requirements, identify suitable actuator locations and develop a top-level mass estimate for an attitude control system, with propellant mass estimates. Identify risks and feasibility issues ("tall poles") with the proposed attitude control concept.

1.1.3 Subtask 3 – Documentation/Deliverables

The dynamics and control model (developed in TREETOPS or another suitable modeling computer code) for the Integrated Symmetrical Concentrator with flexible booms including any additional modifications or enhancements to TREETOPS will be delivered to NASA in the forma of a CDROM. This will contain a PC version of the operational TREETOPS software accompanied by source code and data files.

A final report that documents the dynamics and control model development for the Integrated Symmetrical Concentrator, and documents the trades, mass estimates, recommendations and risks for the proposed attitude control system. Microsoft Word and Power Point will be employed to describe in detail the dynamics and control model development and simulations, etc.

1.2 STUDY GROUNDRULES AND GUIDELINES

TREETOPS is a general purpose multi-body flexible spacecraft dynamics simulation computer program which was used as the modeling tool for performance of this study. Previous to the study, an enhancement was made to the orbital environment model to a general, non-spherical earth model. During the study enhancements were also made to the sensor models to provide features required by our candidate SSP such as an earth target pointing error sensor, a line of sight 3 axis attitude error sensor, and a sun/star presence flag. NASA/MSFC provided ISC geometry and mass properties to us early in the study. In addition, it was agreed that we would freeze this configuration for study purposes. Dr. Stephen Canfield's work for MSFC as a Summer Faculty Fellow would be the basis for our flexible boom model. Bd Systems built a NASTRAN flexible body model of the boom using inputs obtained from reference 1. This flexible body model was reduced to 24 flexible modes and was incorporated into the ISC model.

The controllers defined for the ISC configuration were all conventional continuous, linear controllers. Conservatism in design and implementation was a guiding principle in this study. This allowed all controllers to built using standard TREETOPS features without requiring the use of any special, user-defined functions or subroutines. TREETOPS standard sensor and actuator models were employed to define the controller implementations. This included, in some cases new TREETOPS coding to add or modify a sensor model to fulfill a specific requirement for certain functionality not provided in the previous version.

1.3 GOALS AND LIMITATIONS

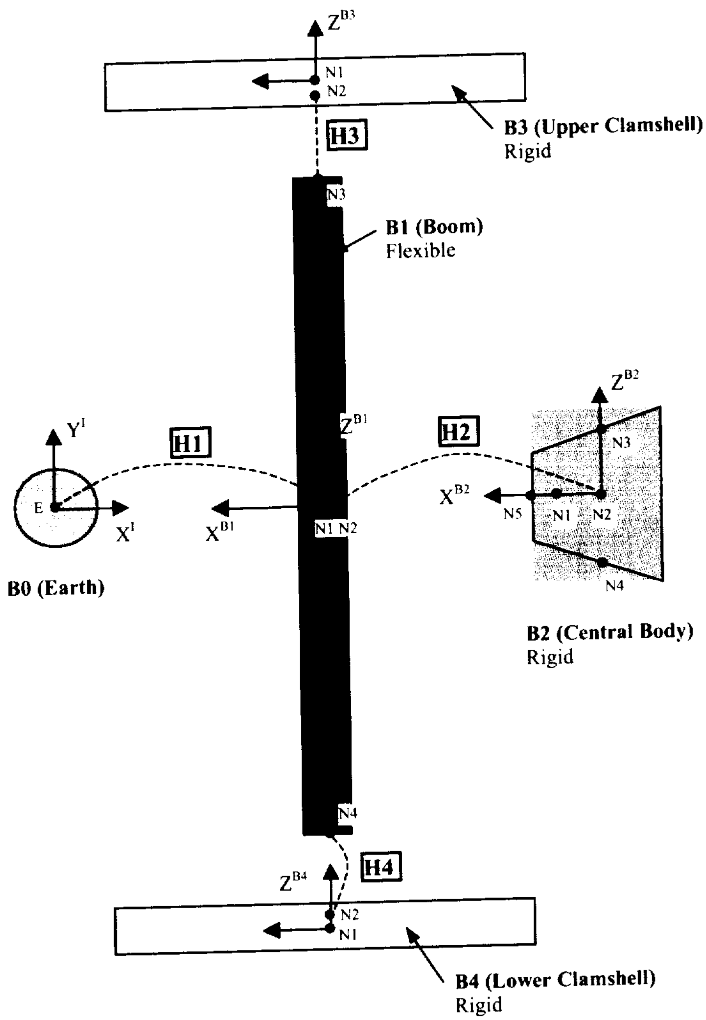
The goal of this study is to develop a range of controllers for the ISC SSP configuration, which demonstrate control capabilities and allow the requirement for consumables and/or momentum storage capacity to be quantified. A total of 4 control concepts were defined and implemented in the TREETOPS ISC simulation. These covered the range from entirely conventional, centralized control to a multi-body distributed control and demonstrated a range of performance levels showing the features, advantages and disadvantages of each. Detailed description and simulation results will be presented in later sections for each. It must be stated that out of necessity, the ISC configuration, which we have used and for which our results are valid, represents a snapshot in the evolution of the ISC configuration. In the larger NRA activities ISC development has continued. It was necessary for the concept we studied to be frozen in order for the study to be performed and the configuration taken represented a consensus compromise.

1.4 ANALYTICAL TOOLS

As mentioned previously, the primary analysis tool employed for this study was the multi-body modeling code TREETOPS, version 10P2 with capability enhancements developed by bd Systems Control Dynamics Division under several NASA contracts including the present one. Secondary analysis tools included the structural modeling, finite element analysis system known as NASTRAN, the CSA NASTRAN variation. We also employed the Math Works Matlab® version 5.3 for processing the data and generating the plots.

2.0 SYSTEM DESCRIPTION

The ISC configuration is illustrated in figure 2.0.1 below as it is laid out for TREETOPS modeling. The model consists of four bodies: 1. The metering structure boom or simply the boom; 2. The solar collector, power converter and radiator, alias the central body; 3. The upper solar concentrator or clamshell; and 4. The lower clamshell. These bodies are described for modeling purposes by their geometry and mass properties shown in the table to the right of the figure. The basic operation of this configuration is to point the central body radiating antenna at the earth station while keeping the clamshells properly pointed to



Body Descriptions

Body 0 – Earth
w.r.t. Geocentric Origin and ECI CS

Body 1 – Boom
Mass Info w.r.t. B1 CM and B1 CS
Mass (kg) 1.6168633E5
Ixx (kg-m2) 6.2852173E11
Iyy (kg-m2) 6.2852173E11
Izz (kg-m2) 6.7057352E8
Ixy,Ixz,Iyz (kg-m2) 0. 0. 0.
Nodes w.r.t B1 Origin and B1 CS
N1 0 0 0 (CM)
N2 0 0 0
N3 0 0 3188.8
N4 0 0 -3188.8

Body 2 – Central Body
Mass Info w.r.t. B2 CM and B2 CS
Mass (kg) 12666300
Ixx (kg-m2) .8543E12
Iyy(kg-m2) 1.5601E12
Izz(kg-m2) 1.3822E12
Ixy,Ixz,Iyz (kg-m2) 0. 0. 0.
Nodes w.r.t B2 Origin and B2 CS
N1 298.323 0 0
N2 0 0 0
N3 0 0 300
N4 0 0 -300
N5 500 0 0

Body 3 – Upper Clamshell
Mass Info w.r.t. B3 CM and B3 CS
Mass (kg) 2046600
Ixx (kg-m2) 1.7E12
Iyy (kg-m2) 1.7E12
Izz (kg-m2) 3.4E12
Ixy,Ixz,Iyz (kg-m2) 0. 0. 0.
Nodes w.r.t B3 Origin and B3 CS
N1 0 0 0
N2 0 0 0

Body 4 – Lower Clamshell
Mass Info w.r.t. B4 CM and B4 CS
Mass (kg) 2046600
Ixx (kg-m2) 1.7E12
Iyy (kg-m2) 1.7E12
Izz (kg-m2) 3.4E12
Ixy,Ixz,Iyz (kg-m2) 0. 0. 0.
Nodes w.r.t B4 Origin and B4 CS
N1 0 0 0
N2 0 0 0

Description	H1	H2	H3	H4
Concept 1A	3- L1(X^{I}),L2(Y^{I}),L3(Z^{I})	1- L1(Z^{B1})	0	0
Concept 2A	3- L1(X^{I}),L2(Y^{I}),L3(Z^{I})	0	2- L1(X^{B1}),L2(Y^{B1})	2- L1(X^{B1}),L2(Y^{B1})
Concept 2B	3- L1(X^{I}),L2(Y^{I}),L3(Z^{I})	0	2- L1(Z^{B1}),L2(X^{B1})	2- L1(Z^{B1}),L2(X^{B1})
Concept 3	3- L1(X^{I}),L2(Y^{I}),L3(Z^{I})	0	3- L1(Z^{B1}),L2(X^{B1}),L3(Y^{B1})	3- L1(Z^{B1}),L2(X^{B1}),L3(Y^{B1})

Figure 2.0.1 TREETOPS Model of SSP Integrated Symmetrical Concentrator.

beam solar energy onto the PV arrays. Each clamshell contains 36 flat mirrors that are set at proper angles to focus a spot of light on the PV array. Each is positioned uniquely such that focus is degraded significantly if the clamshell is rotated about the boom even though the plane of the clamshell is maintained. An early control concept (now referenced as concept 2a) was eventually ruled unacceptable

because it did just that. It was maintained in the study for comparison purposes to study performance and propellant comsumption.

2.1 CONFIGURATION AND ASSUMPTIONS

The reference coordinate system employed for TREETOPS analysis in shown in figure 2.1.1. This is the inertial coordinates system used for dynamic calculations. In this reference frame, the position of the sun relative to the earth changes over the course of the year. In the spring, at the time of the Vernal Equinox

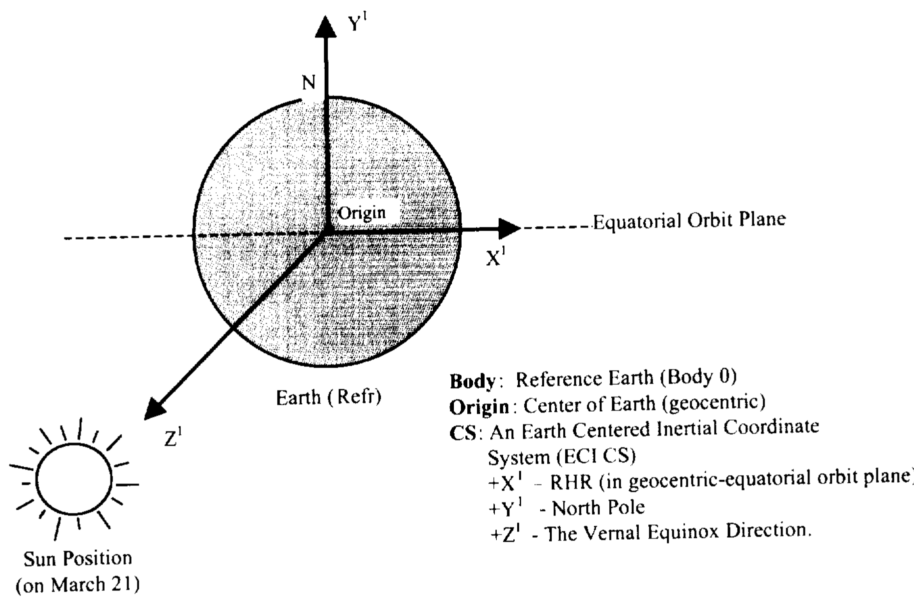


Figure 2.1.1 TREETOPS Inertial Coordinate System.

(VE), around March 21, of the year, is the time of year when the sun appears to pass from the southern to the northern celestial hemisphere through the equatorial plane. Other significant times are June 21, Summer Solstice (SS), sun most northward (23.5° north celestial latitude), September 21, Autumnal Equinox (AE), north to south through the plane and December 21, Winter Solstice (WS), sun most southward (-23.5° celestial latitude). These times provide samples of the different attitudes the ISC must operate in over the course of the year. The first body defined for the ISC is the boom. The boom body axis system is defined with its long axis along Z. The two transverse axes are X and Y respectively and are assumed to be symmetric.

A set of 3 Euler angles defines the TREETOPS hinge 1 rotational degrees of freedom. Figure 2.1.2 shows the orientation of the intermediate axis Z' after rotation through the 1st Euler angle defined about inertial X which rotates the boom Z axis along the inertial Y. The second Euler angle defined is about the intermediate Y' axis. The third Euler angle is about the second intermediate axis Z". The initial position of

the boom, body 1 relative to the TREETOPS inertial frame is specified by the 1-2-3 Euler angle sequence from the TREETOPS inertial frame to the body 1 frame with the angles -90°, 0°, 90° respectively. Figure 2.1.2 shows the initial rotational position of the body 1 frame and the TREETOPS inertial frame. Three translational degrees of freedom are also defined for body 1 and the initial translation position and velocity places the system into a geosynchronous, equatorial orbit. Body 2 is the central body and is positioned by hinge 2 relative to body 1. Only in control concept 1 does hinge 2 have any degrees of freedom defined.

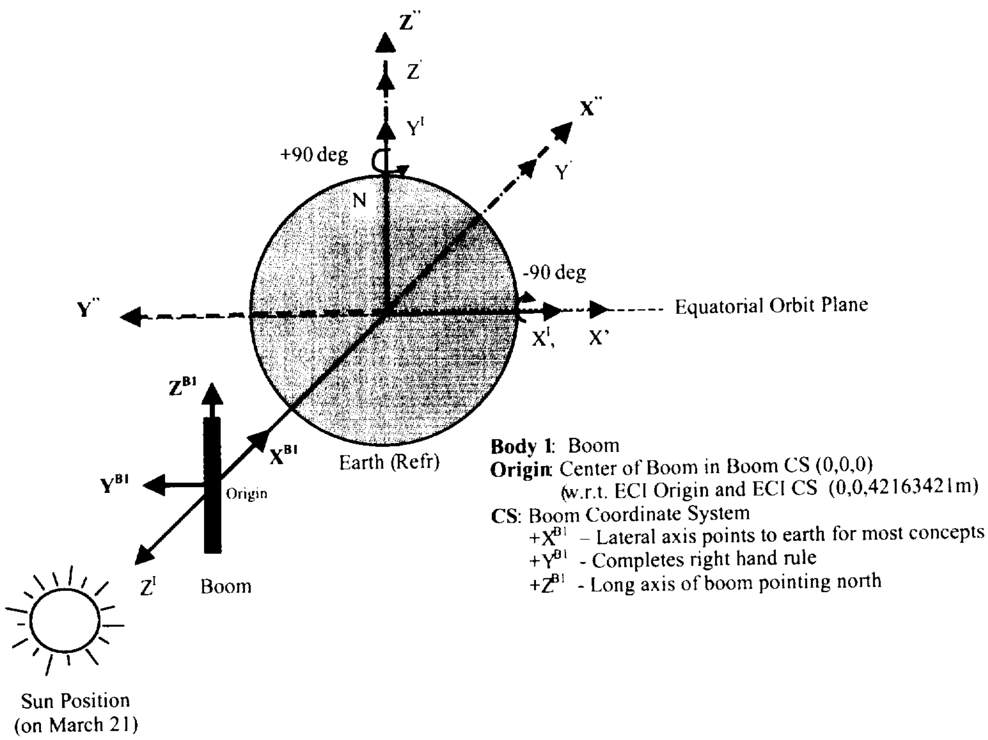


Figure 2.1.2 TREETOPS Body 1 (Boom) coordinate system at Vernal Equnox. Boom CS at Vernal Equinox initial condition = $[90°]_3\ [0°]_2\ [-90°]_1$ expressed as Euler angle sequence.

Concepts 2a, 2b and 3 have all degrees of freedom locked at this hinge. For concept 1, a single rotational degree of freedom is defined for Z axis relative motion. Body 1 and body 2 are aligned initially at the Vernal Equinox. Since body 2, i.e. the central body tracks the earth station, it must rotate at orbital rate, once per day. Thus, except for control concept 1, the boom also rotates once per day.

The clamshells are attached to the upper and lower ends of the boom. The upper clamshell is TREETOPS body 3 and attached to the boom at hinge 3. The lower clamshell is TREETOPS body 4, attached to the boom at hinge 4. Hinges 3 and 4 are defined similarly to each other but are different for each control concept. They range from 0 defined degrees of freedom for concept 1 to 3 defined degrees of freedom for concept 3.

The concepts introduced above are several control scenarios simulated to provide attitude and pointing control for the several components of the ISC. They will be defined in greater detail in a later section. Concept 1 is also occasionally referenced as concept 1A as there was originally a concept 1B. Concept 1B was eventually dropped because we judged it to be insufficiently different from concept 1A.

2.2 GEOMETRY AND MASS PROPERTIES

Figure 2.0.1 summarizes the structure of the TREETOPS model of the ISC as well as its geometry and mass properties. Addition of the component masses yields the total mass of the ISC configuration: 16.921×10^6 kilograms, nearly 17,000 metric tons. The dimensions expressed in figure 2.0.1 were provided by NASA/MSFC in reference 2 along with the component masses. Each major component mass was idealized as a disk, a rod or an assembly of disks and rods. From these assumptions, the moments of inertia were calculated. The results of these calculations are summarized in the table of the figure. The moment of inertia of a rod about its center of mass is

$$I = \frac{1}{12} m l^2 . \qquad [1]$$

Similarly, the moment of inertia of a disk about an axis through its center of mass and normal to the surface of the disk is

$$I = \frac{1}{2} m l^2 . \qquad [2]$$

The moments of inertia about the two transverse axes in the plane of the disk are each half the moment of inertia about the normal, equation 2. These facts are sufficient to estimate moments of inertia for bodies 1, 3 and 4. The moments of inertia of body 2 are computed by adding moments of inertia of 3 disk like structures, representing the two PV arrays and the radiating antenna.

The TREETOPS model description input files for all the control concepts and all the seasonal runs are contained in Appendix A.

2.3 FLEXIBILITY MODELING

The boom was deemed the critical member of the structure from the flexibility perspective and was the only body in the TREETOPS model defined as flexible. Dr. Canfield's study, reference 1, was used as a basis from which we developed a NASTRAN finite element model of the boom structure. Structural modes were generated from this NASTRAN model and the frequencies from this model are contained in Appendix D. The boom flexibility model is developed as a free-free model using the Craig-Bampton reduction technique. A total of 30 modes are calculated and the 24 flexibility modes are taken into TREETOPS to describe the boom flexibility.

The TREETOPS model for the ISC including boom flexibility varied among the different control concepts due differences in the hinge degrees of freedom defined for each. TREETOPS generated mass and stiffness matrices were used to compute combined system modes and frequencies for the uncontrolled systems. These results are presented in Appendix C.

2.4 DISTURBANCE MODELING

The principle disturbances affecting the ISC configuration at synchronous orbit altitude are gravitation and solar radiation pressure. Gravitation determines the orbital motion and the gradient of the gravitational force field causes tidal forces and torques that load the structure and perturb the attitude. These forces/torques are built-into TREETOPS. Reference 3 includes a description of the development of the enhanced gravitation and solar pressure models added to TREETOPS along with the verification of these changes. Especially important in this process is the inclusion of these loading effects on body flexibility and flexible body deformations.

2.4.1 THE GRAVITATIONAL FORCE

The Earth gravitational force field is modeled in TREETOPS by the default field model, which includes field expansion terms through J4 (see Reference 4). Gravity gradient (GG) torques and flexible body

generalized forces are also modeled through this order. Reference 3 contains a detailed development of these expressions. Concerns were expressed regarding the ability of the ISC structures to withstand the GG loading. Simulations did not show this to be a significant problem.

2.4.2 SOLAR RADIATION PRESSURE

The relatively lightweight structures and large surface areas required to capture the solar energy sufficient to radiate approximately 2 gigawatts at the output of the radiator after conversion losses in several stages of conversion makes solar radiation pressure a significant disturbance source along with GG. The clamshells possess the largest surface areas of the ISC structure. Based on the dimensions given in reference 2, 10,400,000 m^2 was the area of each clamshell. These were modeled as planar areas having a normal along the z axis of the clamshell body, a centroid at the attach point of the solar collection/reflection surface and a reflectivity of 100 percent. The boom was modeled in solar pressure as 4 planar surfaces in successive 90 degree positions around its circumference. Each surface was subdivided into 3 segments, a center segment an upper and an lower segment. The center segment had an area of 638,000 m^2, the upper and lower each had areas of 319,000 m^2. These 12 total surfaces areas were attached at the center node of the boom and the upper and lower end nodes of the boom. This model somewhat exaggerated the boom solar pressure area and was deliberately done this way for conservatism and simplicity. The 12 surfaces were used to allow the radiation pressure to act on the separate nodes of the flexible boom and to include to this degree the effects of boom flexibility interacting with the solar radiation pressure. The total area of the boom was still only a small fraction of the area of the clamshells. The central body PV arrays were each modeled by an area of 785,000 m2 and the microwave radiating antenna was modeled by an area of 196,000 m2. The boom radiation pressure model with its 90 degree planar surfaces does produce effects which are occasionally noticeable. These will be pointed out later in our discussion of simulation results.

2.5 CONTROL CONCEPTS

The successful operation of the ISC configuration requires that the clamshells concentrate sunlight on the photovoltaic arrays. The PV arrays must then convert this sunlight into electrical power. This electrical power is then transferred to another converter where it is transformed once more into microwave energy and beamed by a microwave radiator through an antenna to a station on Earth. This process implies several control processes relating to ISC spacecraft attitude and stationkeeping. For operations purposes, it has been decided to maintain the boom in an orientation perpendicular to the orbital plane a so-called POP attitude. From the POP attitude the clamshells must be oriented so that sunlight is collected and reflected onto the PV arrays. This means that each clamshell's normal must be such that that the angle of reflection onto the PV array equals the angle of incidence of sunlight onto the clamshell and all three, the sun, the clamshell normal and the PV array lie in the same plane. Thus, the clamshell normal must be pointed in a direction halfway between the sun and the PV array, which by above assumptions lies in the direction of the orbit normal relative to the clamshell. The clamshell pointing must be sufficiently accurate that the migration of its reflection spot stays on the surface of the PV array. Thirty arc minutes of clamshell motion can cause as much as 1 degree of spot motion and at 3190m separation of clamshell and PV array amounts to approximately 56m of motion. Simultaneously, the energy beam of the central body must point to the Earth station. Electronic beam steering will be used to keep the beam pointed properly, but this can only be used as long as the mechanical antenna pointing is within a small separation of the target. Thus, mechanical pointing of the antenna is required to keep the beam pointed to the earth, which for our application, must be within 30 arc minutes. Based on this discussion, mechanical pointing is required to keep the central body pointed at the Earth while the ISC flies in an equatorial, earth synchronous orbit. Simultaneously, the boom must be maintained aligned with the orbit normal, and the clamshells pointed halfway between the Sun's position and the south or north poles respectively for the upper and lower clamshells. Several concepts have been studied to achieve these control requirements. Also, the ISC's orbital position must be maintained over a particular longitude of earth in a process called stationkeeping. The accuracy required for stationkeeping is understood to be 0.5° of longitude. The focus of this study is spacecraft attitude control. Stationkeeping has not been studied in detail. The propellant estimates given for stationkeeping are made assuming instantaneous balancing of disturbance forces. The following control concepts address attitude control of the ISC configuration only.

2.5.1 CONCEPT 1

The most centralized control concept studied in this activity is concept 1. In this concept, the central body is controlled by a pointing and attitude control system. This system points the antenna at the Earth and holds the roll angle around the antenna line of sight such that the boom is maintained along the orbit normal by virtue of its being structurally hinged to the central body. An Earth target sensor is provided by TREETOPS and is employed in this concept and all the other concepts to provide an error signal for central body pointing control. A star sensor and an idealized pole star target provides a roll error source. The TREETOPS hinge between the boom and the central body has a single degree of freedom such that the central body can rotate about the boom Z axis (see figure 2.1.2). A torque motor actuator provides control torques at hinge 2 from an error signal based on output from a sun sensor. The clamshells are each hinged to the boom with a single degree of freedom hinge to allow raising and lowering them to track the north-south annual sun motion. For TREETOPS implementation of concept 1, this degree of freedom is ignored. It is assumed to operate open loop, maintaining clamshell pointing at the proper north-south angle. Boom yaw is maintained to track the annual solar motion. The detail of instantaneous motion of the sun is not currently modeled in TREETOPS and is ignored in all the concepts.

2.5.2 CONCEPTS 2A AND 2B

The next concept studied in this activity is concept 2A. This was actually the first concept studied. The 2 indicates that 2 axes of clamshell rotational motion are controlled. The A indicates it was the first considered of this type. Clamshell pointing is independently controlled by a controller using sensors and actuators located on the clamshell. The sensor is a special 3-axis line of sight (LOS) sensor that employs 2 guide stars to define a pointing direction and a reference for roll about the LOS. As in concept 1, the actuators employed are moment actuators which produce a pure torque with zero force on the body being controlled. Such an actuator could be realized as pair of thrusters of equal thrust producing forces in opposite directions, whose force lines of action are separated by a nonzero distance or moment arm. In this concept, control of the clamshell pointing depends only on clamshell mounted sensors and actuators, whereas in concept 1, clamshell pointing depended on central body control. Thus, this concept is more distributed than concept 1. The distinguishing feature between concept 2A and concept 2B is the definition of the degrees of freedom defining the hinges between the boom and the clamshells. In concept 2A, TREETOPS hinges 3 and 4 are defined by X and Y gimbal angles, i.e. two angles perpendicular to the long axis of the boom. In concept 2B, hinges 3 and 4 are defined by X and Z gimbal angles. The effect of this subtle difference is that the clamshell rotates about the pointing line of sight in concept 2A but not in concept 2B. The clamshell pointing controller operates the same in both. The rotation in concept 2A results from the rotation of the central body and boom which must rotate once per day to track the Earth target. Since the hinge between boom and clamshell in concept 2A only allows relative rotation about boom transverse axes, the clamshells must rotate with the boom. Hence, the flat mirrors on the clamshells are continuously changing their separation and angular relationship with the PV arrays causing an amount of motion of the reflection spot that was deemed unacceptably large. Thus, concept 2A was eliminated from consideration but is retained for discussion and comparison purposes. This led to concepts 2B and concept 3. In concept 2B, the hinge or gimbal structure between boom and clamshell is first a rotation about the boom Z axis, followed by a rotation about the displaced X axis which is fixed in the clamshell. Thus, the boom once per day rotation is accommodated by the Z axis gimbal and the X axis gimbal accommodates the clamshell north-south tracking of the sun. Both concepts allow residual rotational motions of the boom to perturb clamshell pointing. Hence, some potential for controller interactions exists in these control concepts. For this reason, concept 3 was developed.

2.5.3 CONCEPT 3

In concept 3, the clamshell control is made a full, 3 axis attitude control using the same LOS sensor as in concepts 2A and 2B but now adding a roll torque actuator and employing the roll reference error signal for roll axis control. Again, the control actuators are moment actuators modeled conceptually as force couples. In this concept, the booms are decoupled from the clamshells except for the gravity gradient force. This is accomplished by giving the hinges between boom and clamshells, full, 3 degrees of freedom. This prevents

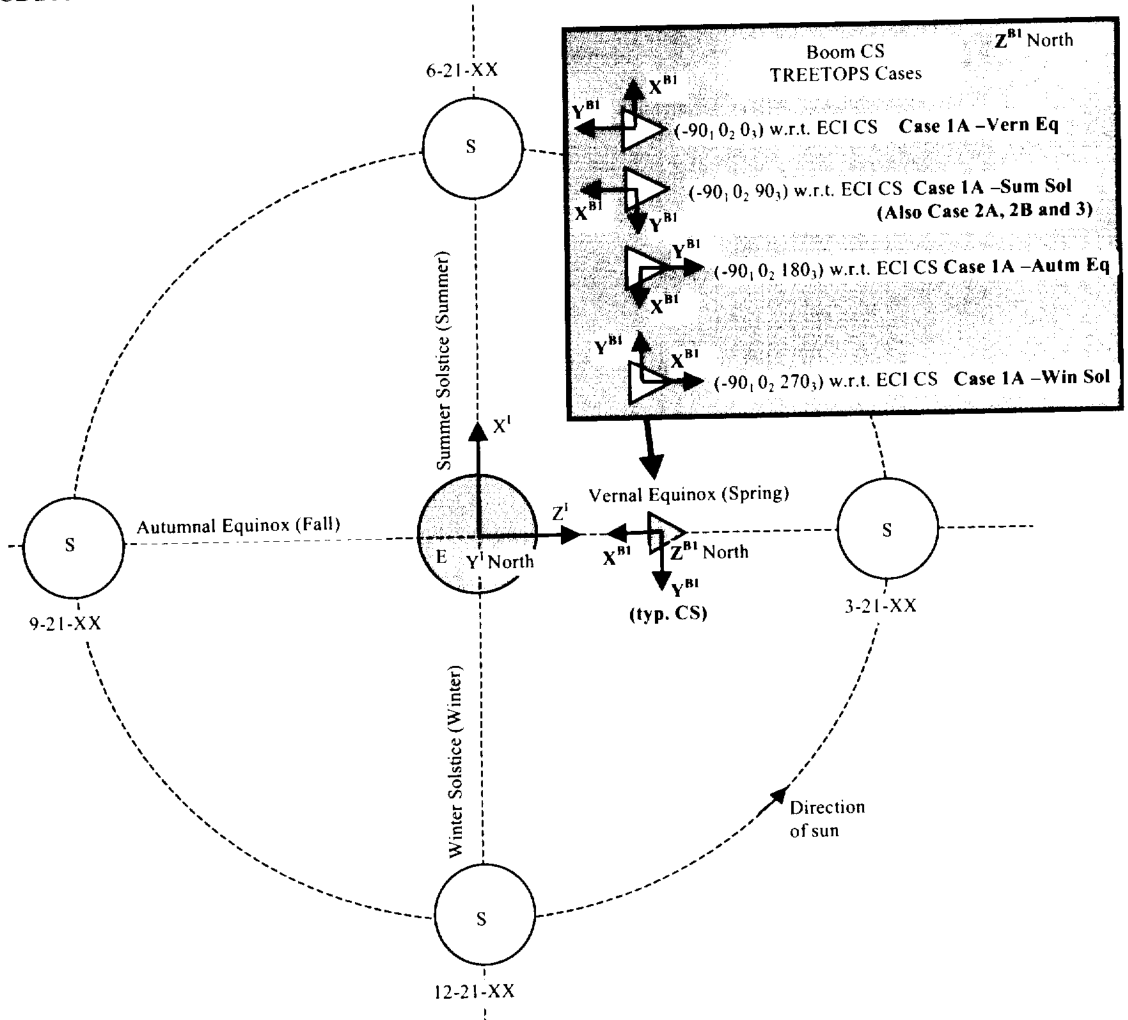


Figure 2.6.1: Body 1 (Boom) Initial CS wrt ECI CS and the Position of the Sun with Respect to the Earth at the Beginning of Each Season (Northern Hemisphere)(Plan View)

torques from being transferred between clamshells and boom and is the most robust ISC controller concept studied.

2.6 SIMULATION STUDIES: FOUR SEASONS AND EARTH SHADOW TRANSIENT PASSAGE

The simulation studies performed on the ISC configuration and the various control concepts were run at various times of the year expected to represent the extremes for the gravity gradient and solar radiation pressure disturbances. These times are the transitional times between the 4 seasons, i.e. Vernal Equinox, Summer Solstice, Autumnal Equinox and Winter Solstice. The Vernal Equinox is the passage of the sun through the equatorial plane going from southern to northern celestial hemispheres and is the first day of spring in the Northern Hemisphere of Earth. The Summer Solstice is the maximum northward motion of the sun in the sky and is the first day of summer. The Autumnal Equinox is the passage of the sun through the equatorial plane going from northern to southern celestial hemispheres and is the first day of autumn or fall. The Winter Solstice is the southernmost motion of the sun in the sky and is the first day of winter. Figure 2.6.1 shows these positions in terms of motion of the sun with respect to the Earth. Figure 2.6.2 shows the same process in side view and represents relationship between the equatorial plane and the ecliptic plane. Also shown in figure 2.6.1are the approximate dates in the year of the seasonal changes and the initial conditions appropriate for the boom angles in each of the control concepts. At the time of the equinoxes, the upper clamshell normal is pointed downward at 135° from north and the lower clamshell

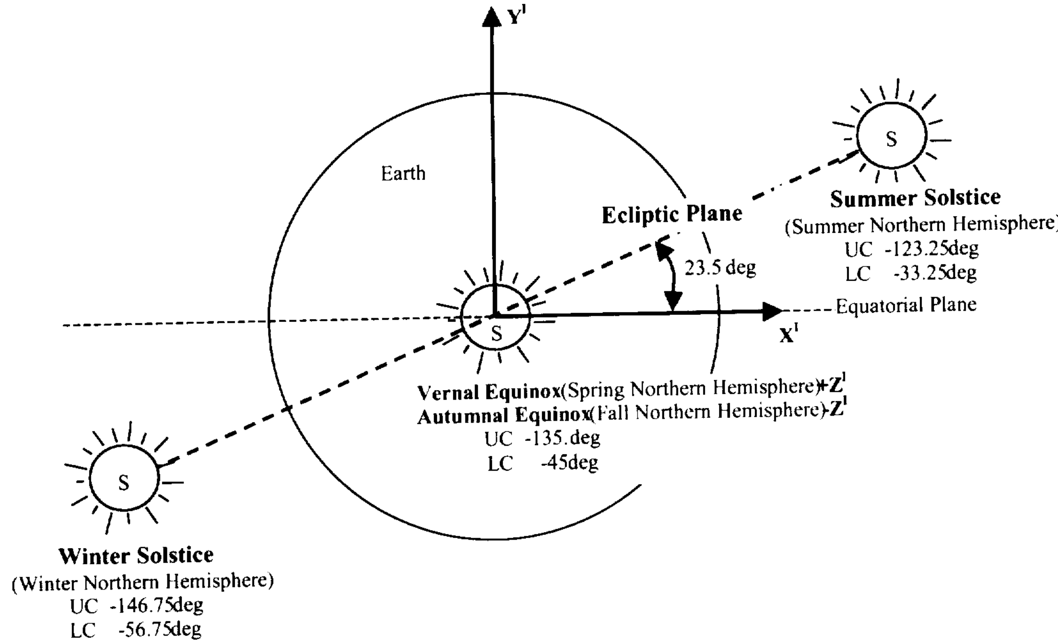


Figure 2.6.2: Position of the Sun with Respect to the Earth at the Beginning of Each Season (Elevation View). Inclination of Ecliptic plane relative to Equatorial plane.

normal is pointed upward at 45° from north. Figure 2.6.2 shows the clamshell angles at each of the seasons. The negative signs on these angles in the figure represents the sense of rotation required to properly position the clamshells. The clamshells redirect and concentrate the sunlight onto the upper and lower PV arrays respectively, with a 90° change of direction of the sunlight at the equinoxes and varying between 113.5 and 67.5 at the other seasons.

The transitions through the Earth's shadow were also studied. Near the equinoxes, the ISC passes through the Earth's shadow once per day. The period of passage lasts somewhat longer than one hour at its longest. This daily passage into the shadow occurs approximately from 1 month before to 1 month after the equinoxes with the duration of shadowing becoming shorter, going to zero when the sun exceeds 8.5° above or below the equatorial plane. The power beam radiation is accompanied by a thrust force of 7 N acting on the central body opposite the pointing direction of the beam, i.e. the negative central body X-axis. This thrust force persists as long as power is flowing in the beam and is appropriate to 2.1 gigawatts. Actual operational scenarios for shadow passage have not been defined but as a worst case condition it was assumed that there was insufficient storage to maintain the power transmission without direct sunlight. The power beam thrust force is cut off as the ISC passes into the Earth shadow and turned on again with passage out. These step force transitions with passage into and out of shadow were considered to be worst case for structure and control excitation. Examination of the Vernal and Autumnal Equinox simulations will reveal this effect. It is most visible in the disturbance forces and torques and the accelerometer sensor outputs.

2.7 CONTROL MOMENT GYROS (CMGS) VS. ION THRUSTERS

The control actuators were modeled in TREETOPS as moment actuators. These are most faithfully realized as pairs of thruster with equal and opposite thrusts at a finite moment arm, which is the perpendicular distance between the force lines of action. These thrusters are assumed to be ion thrusters having a specific impulse appropriate to such devices. Our guidelines for this study are to assume a specific impulse or I_{sp} of 2500 seconds. The moment arms are assumed to be the maximum dimension available in the appropriate axis on the structure being controlled. These assumptions will be employed to estimate the propellant required for control of the various concepts studied. As an alternative, some consideration is given here to momentum storage devices which we shall call CMG's for convenience. We

recognize, however, that these may be momentum wheels or reaction wheels, single or double gimbal CMG's or other devices including flywheels used in the energy storage process. A literature search was performed in search of such devices and their state of development. Little was found, especially in the large size range considered appropriate for space solar power applications. International Space Station (ISS) size devices, approximately 3000 to 3500 Nms stored angular momentum, are considered a starting point size requirement for such systems. Periodic control torque levels in excess of 20,000 Nm with a periods of 12 and 24 hours are typical of levels required and there are occasional control torques in excess of 50,000 Nm. This implies 100,000 or more ISS size CMG's are required for each clamshell and a comparable number are required for central body control. Thus, approximately 300,000 units are required. Each has a mass in excess of 100 kg, so that the total CMG mass exceeds the mass of the ISC. It is clear from this top level discussion that development is required in this area to facilitate utilization of momentum storage technology. This extra structural weight must be traded with the logistical requirements for resupply of thruster propellants to maintain attitude control and stationkeeping. A supplementary consideration is the additional complexity of momentum management techniques required to maintain total stored angular momentum within storage requirements. Significant maneuvering of such a large structure for momentum management purposes would seem to be out of the question. Large scale magnetic torquing also seems impractical. Thus, thrusting for momentum dumping seems the most likely approach. Perhaps such momentum dumping thrust could be held to approximately 10% of that required to control entirely with thrusters. This would result in significant savings but since stationkeeping is also required and appears to be impossible using any other method than periodic thrusting, the value of momentum storage technology for control is reduced. Logistics for propellant resupply is still required.

3.0 RESULTS

It was considered essential to simulate a whole day of operation to assure that at least one cycle of the primary disturbances would be experienced by the systems. Typical simulation runs were 100,000 seconds. This allowed at least 15,000 seconds of time at the beginning of the run for initialization transients to decay so that the steady state motion could be studied. This study was not primarily interested in transient responses due to initialization errors but other transients such as passage through the Earth shadow were of interest because they were repetitive and sure to recur at regular intervals throughout the life of the ISC. Some simulations were run for times as long as 1,000,000 seconds primarily to study the shadow passage transient's longer-term effects. It was only possible to run a small number of such cases because the 10-12 hours of execution time required.

3.1 COMPARISON OF RESULTS FOR ALL CONTROL CONCEPTS OVER FOUR SEASONS -- SYNOPSIS

An extensive set of plots from all the simulation runs for the four control concepts run at each of the four seasonal transition dates is contained in Appendix B. Samples of the data will be discussed in this section to highlight the important results. The Summer Solstice simulations were the most extensively run. In the early phases of the study, all runs were made at this time because of our assessment that it was the time period of the worst case disturbances. Later, it was decided to examine the other seasonal transitions to balance the results and to get a broader sampling of the propellant usage over a typical year for a better estimate of annual totals. A comparison of control concept performance at Summer Solstice is available in section B.3- Figures B.3-1a, B.3-1b, B.3-1c, and B.3-1d show performance of the central body controller for each of the four concepts. Three of the four concepts yield acceptable error performances on the order of a few arc minutes or less. Concept 2A performance showing a yaw axis error repeatedly approaching 19 arc minutes which is marginal at best is shown in figure B.3-1b.. It is apparent from the frequency of the yaw axis error oscillation that boom yaw axis flexibility and the direct coupling of this to the clamshell moment of inertia is a principal factor An equally important factor is that the boom/central body hinge is attached at a point away from the central body center of mass. Thus, boom lateral oscillations couple into central body yaw rotational motion. Boom yaw axis control errors are shown in figure B.3-2a. There are no comparable plots for B.3-2b, etc. since the boom is rigidly attached to the central body in control concepts 2A, 2B and 3. Clamshell pointing errors are shown in figures B.3-3a through B.3-4d. Concept 1 shows a clamshell pointing error in excess of 15 arc minutes which is marginally acceptable. The series of plots in figures B.3-5a through B.3-5d shows the non-gravitational accelerations of the central body. This

vector quantity when multiplied by the total system mass of nearly 17,000 metric tons yields the value of the force that would be required to balance all disturbance forces for perfect stationkeeping control. This calculation yields the total thrust impulse for stationkeeping as determined in this study. The results of this calculation are shown later. Control torques are plotted in figures B.3-6a through B.3-9d for the Summer Solstice cases.

Control concept 1 was run at each of the 4 seasonal transition dates over the year. However, the initial conditions assigning pointing directions to the clamshells were recently discovered to be in error for all except Summer Solstice cases. Thus, results for VE, AE, and WS are not of value for calculating propellant usage. Since no controller is actively processing their error information, they were not being actively driven to proper pointing. This passive control, relying on open loop operation was the attractive feature for this concept, expected to reduce requirements for propellant and minimize complexity. The adverse aspect of the concept was the expected reduction in pointing accuracy and reliance on structural rigidity of the system and the control loads which were being transferred through the boom. Since the boom is extremely flexible in rotation about its slender axis, design of a controller acting in this degree of freedom must be extremely low gain so that the structure is not overstressed and no instabilities are created. In spite of the erroneous IC's behavior of the central body controller and the boom controller results are judged to still be of value. The nature of the initialization error at AE, WS, and VE is that yaw angle of the clamshells is 90°, 180°, or -90° from where they should be. This makes the calculations of solar radiation pressure and gravity gradient torques and the propellant required in error. No statements can be made relating to worst cases here. A valid technique here is to compare the SS results for concept 1 with SS results for concept 3.

The next section summarizes these results to estimate the amount of propellant required to maintain control of the ISC configuration for a year and provide stationkeeping.

3.2 THRUST REQUIREMENTS COMPARISON

The total propellant required for one year's operations is calculated in a series of tables presented as part of Appendix B. Table B.1-1 through B.1-4 presents results for concept 1. As stated above, the values presented as daily totals for AE, WS, and VE are not valid. Thus, the annual total is also not valid.

Table 3.2.1
Predicted Thrust Requirements for Concept 1, Concept 2A, Concept 2B, Concept 3 and Stationkeeping

Description	Daily Total					Est. Annual Total ave x 365.25
	VE	SS	AE	WS	ave	
C1	97.	440.	101.	440.	270.	98475.
C2A	795.	1669.	808.	1637.	1227.	448217.
C2B	135.	478.	139.	480.	308.	112453.
C3	133.	474.	137.	474.	305.	111243.
Stationkeeping C1	389.	415.	400.	415.	405.	147917.
Stationkeeping C2A	342.	376.	356.	376.	363.	132444.
Stationkeeping C2B	342.	375.	355.	376.	362.	132296.
Stationkeeping C3	342.	376.	355.	376.	362.	132337.

Notes:
1) See Table B.4-1
2) Control based on predictions in tables B.1-5 (for C1), B.3-1 (for C2A), B.3-5 (for C2B) and B.2-1 (for C3)
3) Stationkeeping baseed on predictions in tables B.1-6 (for C1), B.3-2 (for C2A), B.3-6 (for C2B) and B.2-2 (C3).

However, SS results are valid. At the Summer Solstice, concept 1 requires 440 kg of propellant for pointing and attitude control and 415 kg are required for perfect stationkeeping control. Concept 3 requires 474 kg of propellant for pointing and attitude control and 376 kg for perfect stationkeeping. Since concept 1 results for AE, WS, and VE are not valid, estimates for usage over a year are made by prorating the SS usages to the other dates relative to concept 3 which is valid over all the dates. The same method is used for the other concepts 2A and 2B. Table 3.2.1 summarizes the results for propellant consumption for the four concepts. An additional point needs to be made with respect to stationkeeping estimates. Stationkeeping disturbance forces are assumed to be the same over all the concepts since they only depend on position and orientation of components, and these must be virtually the same for all concepts. The results in tables B.1-1 through B3-8 show that concepts 2A, 2B and 3 require virtually identical amounts of propellant while concept 1 requires a somewhat greater amount. This is related to the placement of the 3 axis accelerometer on body 1 at node 2 for concept 1 and on body 2 at node 2 for the other concepts. Nodes 2 on bodies 1 and 2 are constrained to be co-located. This forces the accelerations to be the same vectorially. However, body 1 in concept 1 is controlled to point to the sun while body 2 is controlled to point to the Earth. As a result, body 2 rotates once per day, while body 1 is non-rotating. The vector force required for stationkeeping is the same but it is resolved along two different axis systems. This makes the thruster forces which are assumed to be aligned with the coordinate axes different in the two cases. As an example to illustrate this, consider the case where the stationkeeping force is constant in the inertial frame, directed along one of the thrusters. In the second body, rotating once per day, the stationkeeping force varies sinusoidally along two of the thrusters. Comparing the two, one finds that the total propellant usage in the rotating body is $4/\pi$ times propellant usage in the stationary body. In the ISC stationkeeping case, the stationkeeping force is not constant in either inertial or rotating bodies so the problem is more complex. Our table of results show that concept 1 usage is approximately 10% higher than the other concepts. Based on this discussion it is clear that the 10% difference is due to the difference in the rotation state of the thrusting body. In this analysis, it was assumed that all stationkeeping thrust was applied at either the central body or the boom. A detailed design for stationkeeping would likely distribute the stationkeeping force as closely as possible to match the distribution of stationkeeping disturbances to minimize any structural deformations due to differential loading effects. It is assumed here that most of the solar pressure loading would be on the clamshells. If this were balanced by a stationkeeping force applied at the central body, a structural deformation of the boom would result.

Pointing and attitude control in TREETOPS is based on the use of force couples, which produce zero net force acting on the body being controlled. These thruster pairs are assumed to be separated by the maximum dimension available on the controlled body. Since two thrusters are firing at the same time, each separately contributes half the moment. Consequently, the appropriate moment arm to employ for propellant consumption calculations is half the maximum separation distance between thrusters. For example, the clamshell thruster moment arm is the clamshell radius which is taken from clamshell sketches as 1800m and from central body sketches as 500m. The moment arms must be divided into our control torque estimates to determine the thrust force required. In addition, the thruster's specific impulse or I_{sp} also must be divided into the thrust force to calculate the weight flow rate of propellant in N/s which in turn must be divided by g = 9.81 m/s to calculate kg/s of propellant flow. Our guidelines for this study were to use 2500 sec as the thruster specific impulse appropriate to expected ion thruster level of technology available for the ISC. The above calculations employed these assumptions.

As a secondary consideration, it is worth noting that our calculations of total propellant required for control and stationkeeping assume no advantage is taken of opportunities to combine these processes. This is quite conservative. For example, consider the case where stationkeeping requires a force along X of 50N and pointing and attitude control requires a pair of thrusters firing at 25N along + and – X respectively. A single thruster producing 50N along + X could simultaneously satisfy both requirements if placed at the position of the pointing and attitude control 25N thruster with no additional use of propellant for stationkeeping. It is probable that most or all of the stationkeeping force could be combined with attitude and pointing control. Alternatively, it may not be necessary to continuously balance the stationkeeping acceleration forces. Half a degree of error in geosynchronous orbit position is allowed before any correction is required and since much of the stationkeeping accelerations are periodic, much of the stationkeeping drift may balance over time. Thus, the total propellant usage will be strongly dominated by attitude and pointing control requirements. More study of this phenomenon is required to more accurately

estimate its impact on propellant usage. Our scope does not permit us to delve into this phenomenon. Interestingly, our results indicate that pointing/attitude control and stationkeeping propellant requirements when considered separately are roughly equal. Thus, we can probably combine the requirements for both by taking the larger of the two and adding 10%. It appears to be quite conservative to take the two separately and add. Perhaps for now that is the thing to do until more study reveals better estimates.

From the previous discussion, the SS propellant daily total for control and stationkeeping in concepts 1 and 3 were each approximately 850 kg. Concept 3 annual consumption is most accurately calculated over the year and according to tables B.2-3 and B.2-4 in Appendix B yields an annual total of 243,600 kg or 244 metric tons. We can infer from the above that concept 1 propellant usage is the same. <<<<rewrite>>>>

3.3 WEIGHT REQUIREMENTS COMPARISON

Propellant does not appear to be a significant discriminating factor in the weight considerations. The primary differences between concepts for weight considerations is the number of degrees of freedom at hinges H2, H3 and H4. Recall that H2 is the hinge between the central body and the boom and that H3 and H4 are the connections between the boom and the two clamshells. Concept 1 may require a simpler hinge structure at H3 and H4 but will likely more than make up for this simplicity by the complexity and weight of the actuator structure required at H2. Concept 2A has been identified as unacceptable because of the rotational motion induced on the clamshells about their surface normals as well as the unacceptable pointing oscillation and related propellant usage shown above. Concept 2B, which is a modest variation of the 2 degrees of freedom at hinges H3 and H4 from concept 2A, produces significantly better performance than 2A and propellant consumption that is comparable to 1A and 3. Overall there does not appear to be a significant weight differentiation between acceptable control concepts.

3.4 IMPLEMENTATION COMPLEXITY COMPARISON

Concept 3 appears to be the most complex control concept defined in this study since it has more axes being controlled. Examination of the control performance indicates that it also produces the best overall performance of all the concepts. In addition, it produces the least loading on the boom, isolating it from any disturbance torques from the clamshell. In our model, no frictional torques were generated at hinges H3 or H4. The realization of such a hinge may require actively controlled devices such as magnetic suspension. The loads required to be supported at these joints appear to be modest, perhaps of the order of 100-200 N. Adjusting to include a safety factor may drive this to 500N. This would appear to be within achievable levels of magnetic bearing technology, though perhaps other technologies should be examined.

Sensor requirements would appear to be within present state of the art for star trackers and sun sensors. The LOS sensor assumed for pointing the clamshells could be realized by combinations of these devices or perhaps a sun sensor measuring the position of the sun and an artificial star on the PV array being tracked by a tracker on the clamshell. Roll error sensing requirements would be quite modest for this operation. Our controllers were purposely made quite simple, not applying any pressure to the boundaries of control state of the art.

3.5 OVERALL ASSESSMENT COMPARISON

It appears that control of the ISC configuration is feasible as long as ion thrusters of sufficient size for stationkeeping application are available. This implies thruster of several Newtons in thrust and throttleable, although the throttling effect may be achieved by turning on or off individual thrusters in large clusters of these devices. The plumbing requirements for such a system may be a challenging problem, especially the inclusion of the necessary redundancy. Of the control concepts studied, concept 1 is the simplest and concept 3 is the overall best. It does not appear that concept 1 is sufficiently simpler nor uses sufficiently less propellant to be judged preferable. Concept 3 has the best performance, therefore the most margin and seems to present the least risk.

4.0 SUMMARY AND CONCLUSIONS

The Integrated Symmetrical Concentrator Space Solar Power Satellite configuration has been analyzed and simulated in a multi-body, flexible body analysis. This analysis and simulation included the effects of body structural flexibility, gravitation and solar radiation pressure disturbances. Four control concepts were developed and implemented for this configuration.

4.1 CONTROLLERS

The controllers developed for the ISC configuration were conventional and analog in their implementation. Angular position sensors were used to compute errors and analytically derived rates based on the sensed errors were used in PD (position and derivative) feedback linear controllers. These controllers employing moment actuators on the controlled bodies were implemented through the built-in TREETOPS linear control architecture. The input files that accomplish this are included in Appendix A. Issues related to discrete processes and sampling were bypassed and ignored by the assumption of continuous, analog control. Digital implementation and related issues are not expected to be a problem as these techniques have been standard for many years and such issues are well understood. Controllers were purposely kept simple and basic to preclude concerns related to realizability. No consideration was given to problems related to construction or erection of the ISC system into POP attitude, though this is expected to be a considerable problem in its own right. Also, no consideration was given to maneuvers and little consideration to transient responses. Initialization transients were present in most simulation runs and inadvertent errors in initialization revealed robust behavior in most cases in ability to take out such errors though the torques required to do so were in many instances unrealistically high since no limiting was applied to the actuators. Complete results in plot form are contained in Appendix B.

4.2 MODELS

The principal analysis tool employed for this study is an enhanced form of the multi-body analysis and simulation code TREETOPS. This has been enhanced as explained elsewhere in this report body. Three of the four bodies in the ISC model were treated as rigid. The fourth, the long slender boom used as the metering structure for the clamshells, was modeled in its flexibility. A Nastran model was developed for this purpose. The flexible mode frequencies are presented in appendix C for the boom in various loaded conditions as defined by TREETOPS, which calculated an appropriate mass and stiffness matrix from the inputs. The details of the Nastran model are presented in Appendix D.

4.3 DISTURBANCES

The enhanced TREETOPS provides for detailed modeling of gravitational forces and moments as well as for solar radiation pressure. Additionally, included in TREETOPS though not considered significant for this study are aerodynamics and magnetic fields. A full gravity model is implemented supplementing the circular and near circular orbit models previously available. The gravity enhancement included a treatment of flexible body loading, which was previously ignored. Power beam radiation force was also included because of its potential for significant transients as it is turned off and on and also for its ability to contribute to the stationkeeping disturbance environment.

4.4 FEASIBILITY ISSUES

Feasibility of the control concepts studied in this report seems to be virtually assured by the conservative and conventional nature of the controllers defined. Perhaps the biggest question would be the feasibility of producing sufficiently large ion thrusters and gathering and storing sufficient propellant to drive them. Questions related to alternative control methodologies such as momentum management exist related to feasibility and these have been discussed in the report. In summary, momentum management techniques would seem to offer only marginal ability to reduce propellant required and would not seem to offer any significant opportunities to save weight. In fact, additional weight appears to be required and/or considerable development to achieve efficiencies in momentum storage perhaps through combining

momentum storage with flywheel energy storage may offer some hope. Current literature does not seem to offer much hope here.

5.0 FUTURE WORK

As the ISC or other configurations are carried forward into more detailed designs, opportunities exist to revisit and enhance the control concepts developed in this study or to add new ones. Significant issues related to construction/erection of the ISC and the dynamics associated with resupply and routine maintenance are fertile areas for analysis and modeling. Greater fidelity in the modeling process, more consideration of body flexibility are other areas of future work and study. Digital control/sampling effects may be added and more exotic controllers are other areas for future study when the number of configurations is narrowed and the geometry and mass properties are better known and firmed up. Combined effects due to thermal heating and cooling and structural interactions are also areas needing study.

6.0 REFERENCES

1. **Design of Structural Elements for the Integrated Symmetrical Concentrator**, August 2000, Dr. Stephen Canfield, Assistant Professor, Tennessee Technological University, Department of Mechanical Engineering. Sponsored by Dr. Connie Carrington/FD02, NASA/MSFC
2. **ISC_Mass.PPT,** July, 21, 2000, e-mail, received from Dr. Connie Carrington/FD02, NASA/MSFC.
3. **Space Solar Power Multi-Body Dynamics Modeling Final Report,** TCD20000119A, May 30, 2000, Prepared for Purchase Order No. H-31973D, Prepared by John R. Glaese.
4. **Orbital Motion, Third Edition**, A. E. Roy, Published under the Adam Hilger imprint by IOP Publishing Ltd, ISBN 0-85274-228-2, 1988, p. 511.

Appendix A

TREETOPS Model Descriptions

TREETOPS model descriptions of the SSP ISC Configuration for concept 1, concept 2A, concept 2B and concept 3 are given herein. Specifically, the following files are provided herein.

INPUT:

- .int file – Problem Definition (data entered using TREESET)
  define bodies, hinges, sensors, actuators, interconnects, etc.
- .lin file – Defines the A, B, C, D matrix for
  xdot = Ax + Bu
  y = Cx + Du
- los.dat – Used for locating a los vector between two star position vectors
- solar_pressure.dat – Solar Pressure Definition: body, node, area,
  reflectivity factor, outward normal, centroid
- .flx file – Flex data file [SSP Boom (Body 1) modeled as flexible]
  An excerpt is given herein. A full flex file is provided in delivered data package.

OUTPUT:

- .CRF file – Cross-reference variables (used to interpret results)
- .MAT file – TREETOPS matrix format data file (read into MATLAB) –
  not given here, but provided in delivered data package

This appendix is organized as follows:

First, some general figures and tables are given. Then, information specific to each concept is given.

A.1 Concept 1 Definitions and TREETOPS files
- Sensor Definitions
- Actuator Definitions
- Interconnect Definitions
- TREETOPS files:
  - Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx
  - Vernal Equinox (VE): .int
  - Autumnal Equinox (AE): .int
  - Winter Solstice (WS): .int

A.2 Concept 2A Definitions and TREETOPS files
- Sensor Definitions
- Actuator Definitions
- Interconnect Definitions
- TREETOPS files:
  - Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

A.3 Concept 2B Definitions and TREETOPS files
- Sensor Definitions
- Actuator Definitions
- Interconnect Definitions
- TREETOPS files:
  - Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

A.4 Concept 3 Definitions and TREETOPS files

- Sensor Definitions
- Actuator Definitions
- Interconnect Definitions
- TREETOPS files:
  - Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx
  - Vernal Equinox (VE): .int
  - Autumnal Equinox (AE): .int
  - Winter Solstice (WS): .int

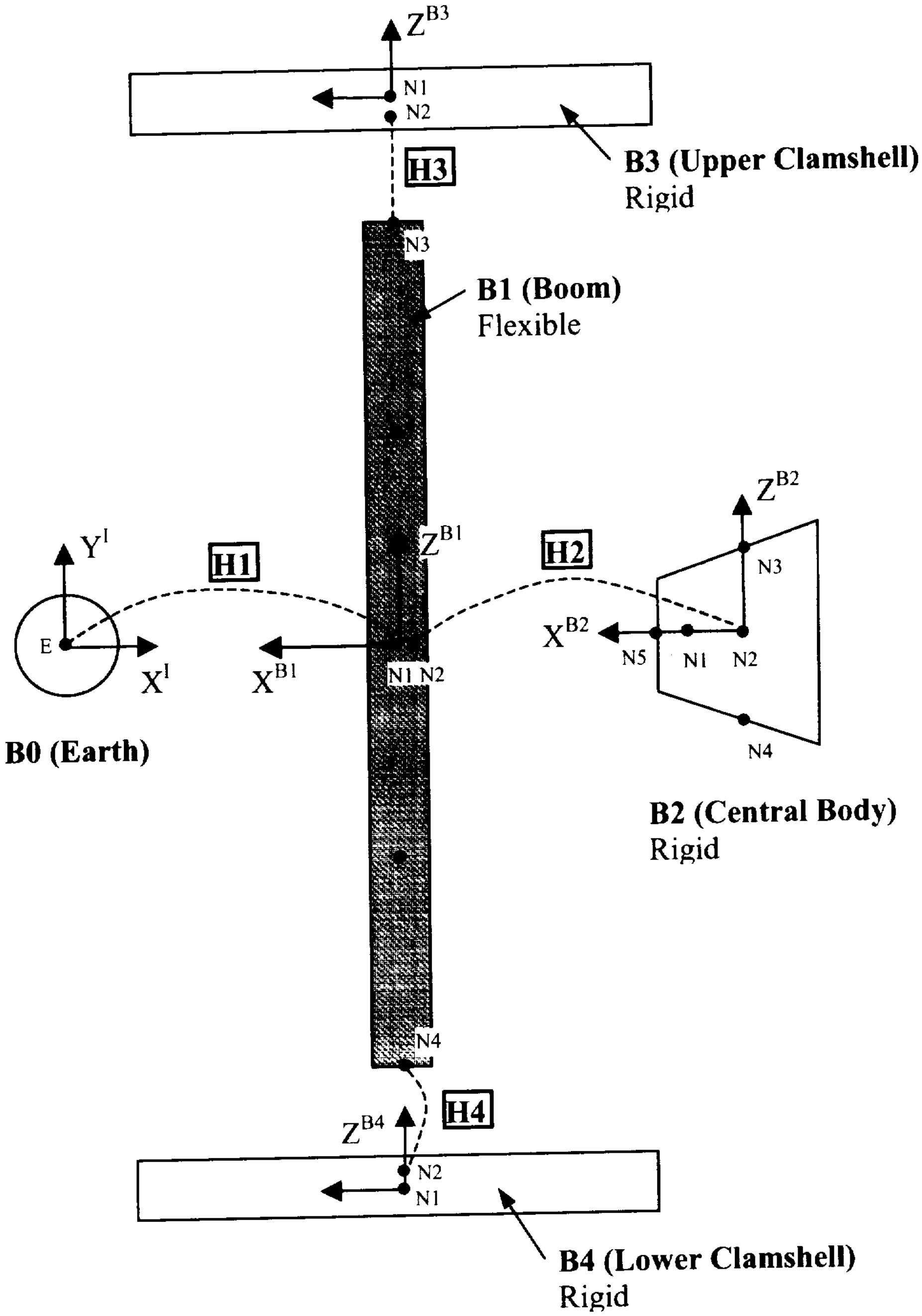
In order to edit TREETOPS use treesel.bat.. For example,

```
treesel.bat  isc3_flex_sol
```

In order to run TREETOPS use treetops.bat. For example

```
treetops.bat isc3_flex_sol
```

A graphical sketch of the TREETOPS model of the SSP ISC configuration is provided in Figure A.1 for convenience. The TREETOPS inertial coordinate system is given in Figure A.2. A typical TREETOPS body 1 (boom) coordinate system at vernal equinox, typical boom orientation for case 1 SS, case 2A, 2B and 3, is given in Figure A.3. The body 1 (boom) initial coordinate system with respect to the earth centered inertial coordinate system (ECI CS) and the position of the sun with respect to the earth at the beginning of each season (northern hemisphere)(plan view) is given in Figure A.4. The position of the sun with respect to the earth at the beginning of each season (northern hemisphere) (elevation view) is given in Figure A.5. The initial condition pitch angles of the upper and lower clamshells is given in Figure A.6. The initial conditions in TREETOPS for body 1 (boom), body 2 (central body), body 3 (upper clamshell), and body 4 (lower clamshell) for concept 1, concept 2A, concept 2B and concept 3 are given in Tables A.1a and A.1b. (Later, it was realized that the initial conditions for body 3 and 4 (UC and LC) for concept 1 VE, AE, and WS were not entirely correct. For concept 1 VE, AE and WS, the initial conditions for UC and LC pitch angle were correct, but the initial condition for the UC and LC yaw angle with respect to the boom was not correct.)



Body Descriptions

Body 0 – Earth
w.r.t. Geocentric Origin and ECI CS

Body 1 – Boom
Mass Info w.r.t. B1 CM and B1 CS
Mass (kg) 1.6168633E5
Ixx (kg-m2) 6.2852173E11
Iyy (kg-m2) 6.2852173E11
Izz (kg-m2) 6.7057352E8
Ixy,Ixz,Iyz (kg-m2) 0. 0. 0.
Nodes w.r.t B1 Origin and B1 CS
N1 0 0 0 (CM)
N2 0 0 0
N3 0 0 3188.8
N4 0 0 -3188.8

Body 2 – Central Body
Mass Info w.r.t. B2 CM and B2 CS
Mass (kg) 12666300
Ixx (kg-m2) .8543E12
Iyy(kg-m2) 1.5601E12
Izz(kg-m2) 1.3822E12
Ixy,Ixz,Iyz (kg-m2) 0. 0. 0.
Nodes w.r.t B2 Origin and B2 CS
N1 298.323 0 0
N2 0 0 0
N3 0 0 300
N4 0 0 -300
N5 500 0 0

Body 3 – Upper Clamshell
Mass Info w.r.t. B3 CM and B3 CS
Mass (kg) 2046600
Ixx (kg-m2) 1.7E12
Iyy (kg-m2) 1.7E12
Izz (kg-m2) 3.4E12
Ixy,Ixz,Iyz (kg-m2) 0. 0. 0.
Nodes w.r.t B3 Origin and B3 CS
N1 0 0 0
N2 0 0 0

Body 4 – Lower Clamshell
Mass Info w.r.t. B4 CM and B4 CS
Mass (kg) 2046600
Ixx (kg-m2) 1.7E12
Iyy (kg-m2) 1.7E12
Izz (kg-m2) 3.4E12
Ixy,Ixz,Iyz (kg-m2) 0. 0. 0.
Nodes w.r.t B4 Origin and B4 CS
N1 0 0 0
N2 0 0 0

Description	H1	H2	H3	H4
Concept 1	3- L1(X^I),L2(Y^I),L3(Z^I)	1- L1(Z^{B1})	0	0
Concept 2A	3- L1(X^I),L2(Y^I),L3(Z^I)	0	2- L1(X^{B1}),L2(Y^{B1})	2- L1(X^{B1}),L2(Y^{B1})
Concept 2B	3- L1(X^I),L2(Y^I),L3(Z^I)	0	2- L1(Z^{B1}),L2(X^{B1})	2- L1(Z^{B1}),L2(X^{B1})
Concept 3	3- L1(X^I),L2(Y^I),L3(Z^I)	0	3- L1(Z^{B1}),L2(X^{B1}),L3(Y^{B1})	3- L1(Z^{B1}),L2(X^{B1}),L3(Y^{B1})

Figure A.1: TREETOPS Model of SSP Integrated Symmetrical Concentrator

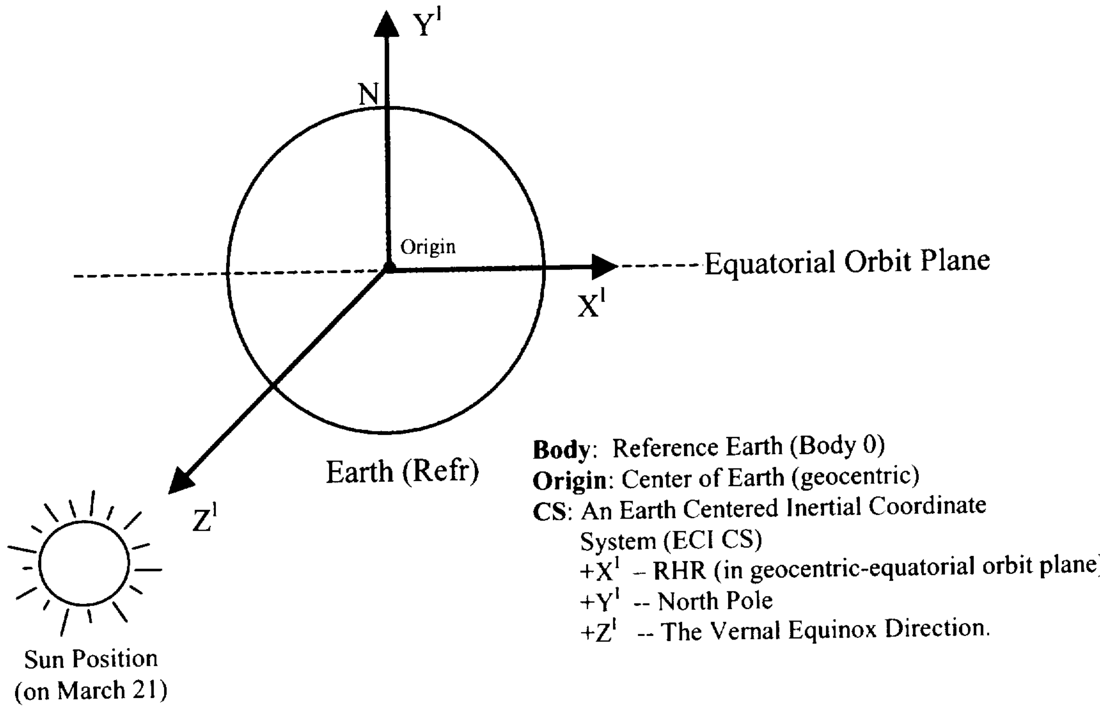


Figure A.2: TREETOPS Inertial Coordinate System

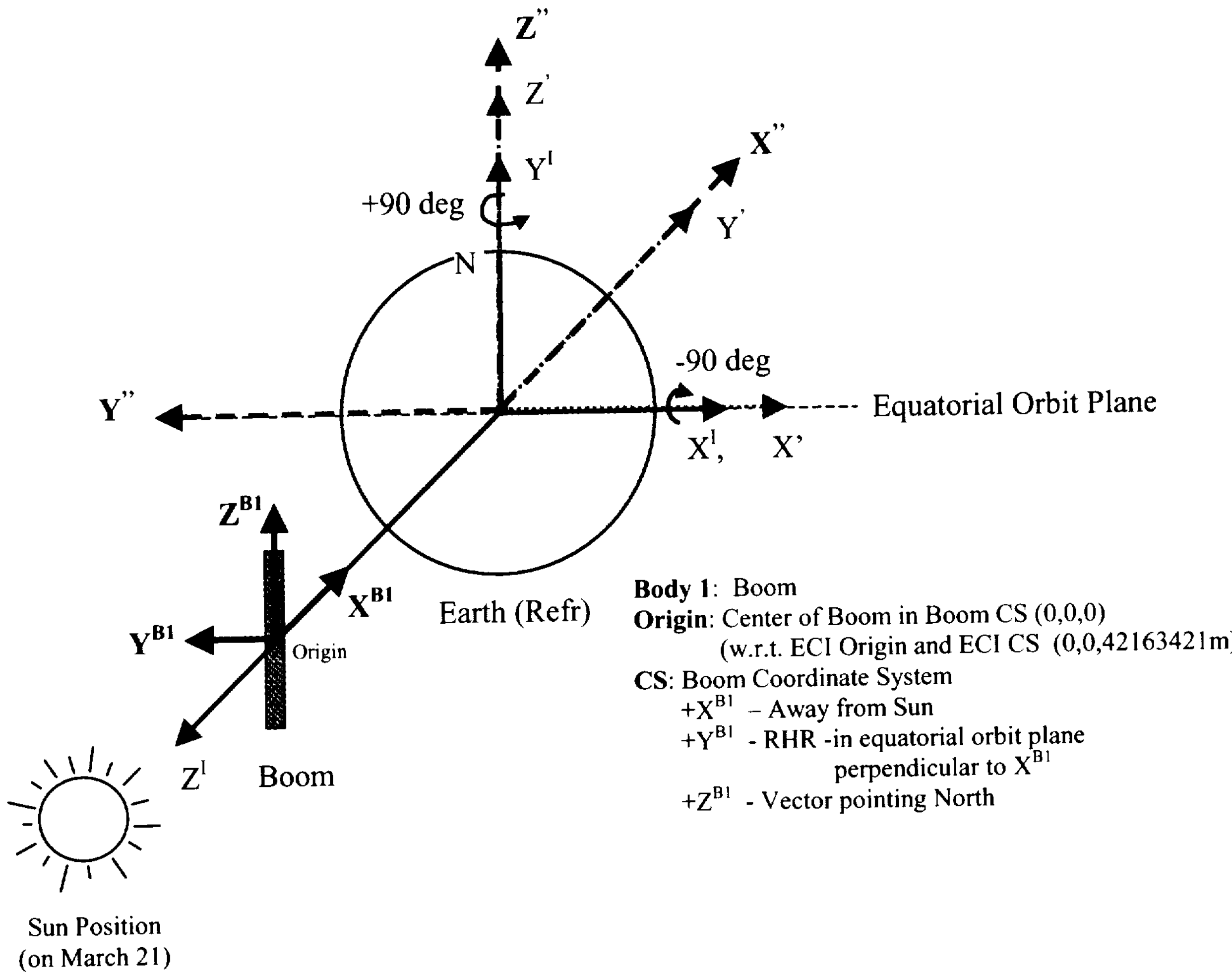


Figure A.3: Typical TREETOPS Body 1 (Boom) Coordinate System at Vernal Equinox
(Typical Boom Orientation for Case 1 SS, Case 2A, 2B and 3)
Boom CS at Vernal Equinox = $[90]_3[0]_2[-90]_1$ * ECI CS

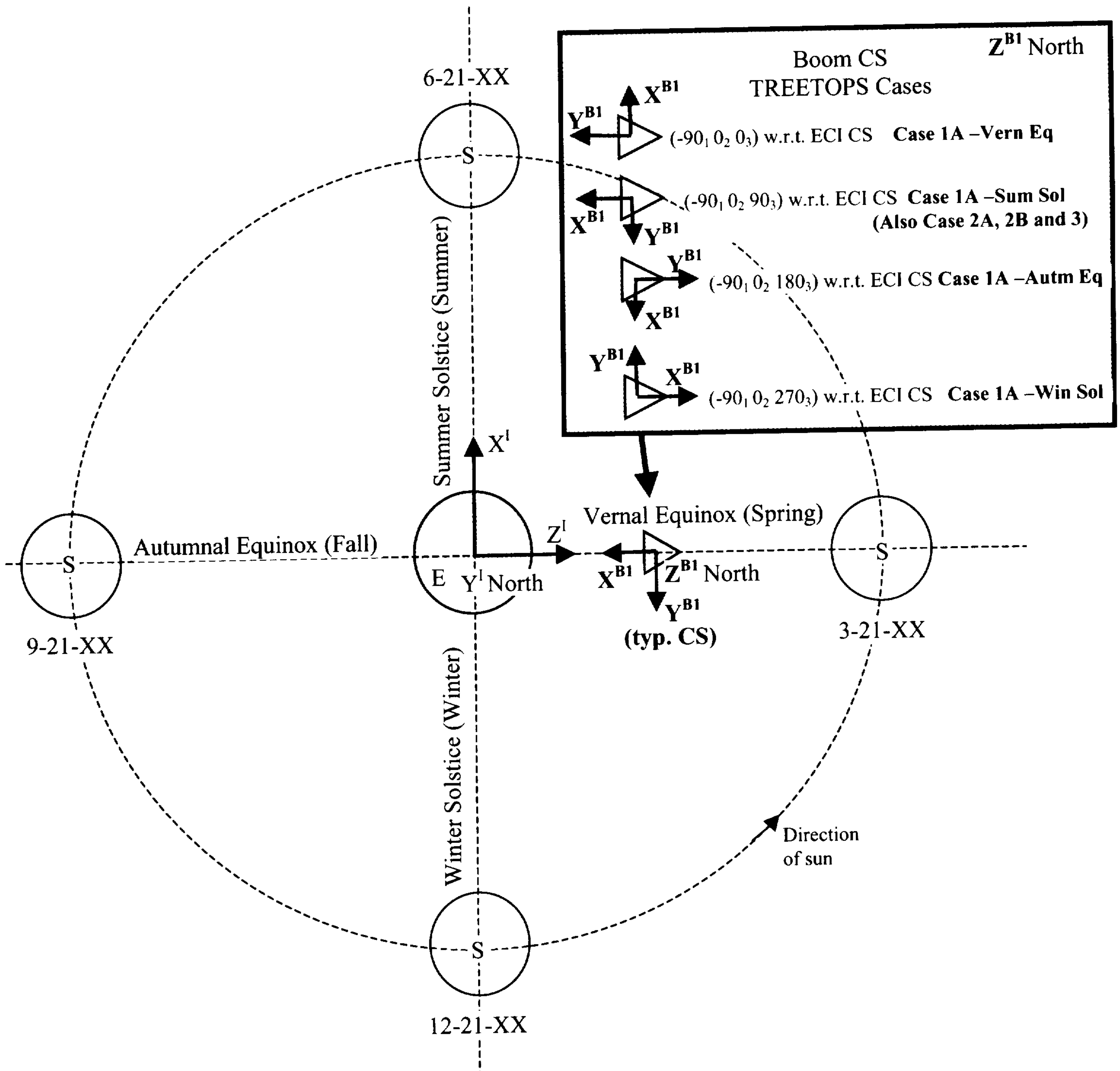


Figure A.4: Body 1 (Boom) Initial Coordinate System with respect to the Earth Centered Inertial Coordinate System (ECI CS) and the Position of the Sun with Respect to the Earth at the Beginning of Each Season (Northern Hemisphere)(Plan View)

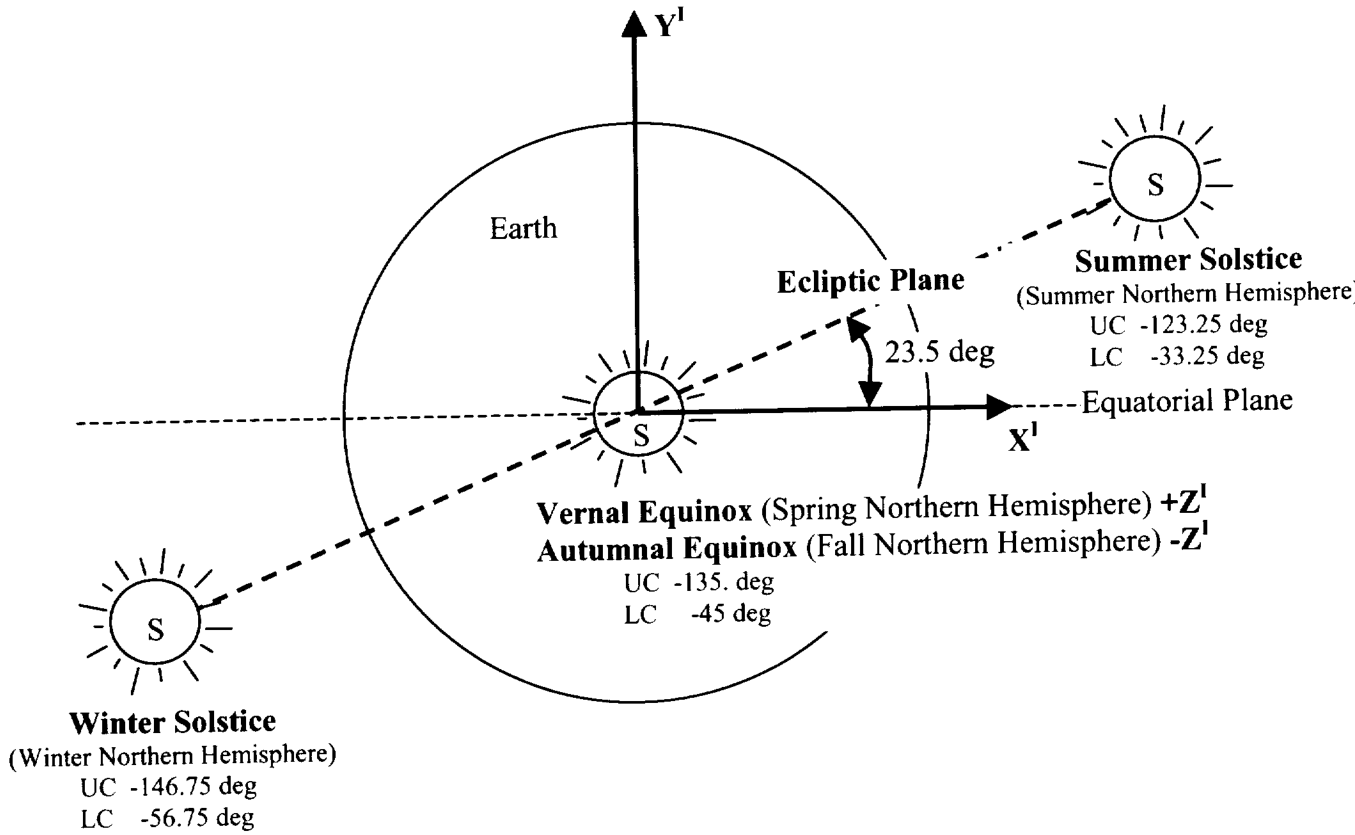


Figure A.5: Position of the Sun with Respect to the Earth at the Beginning of Each Season (Northern Hemisphere) (Elevation View)

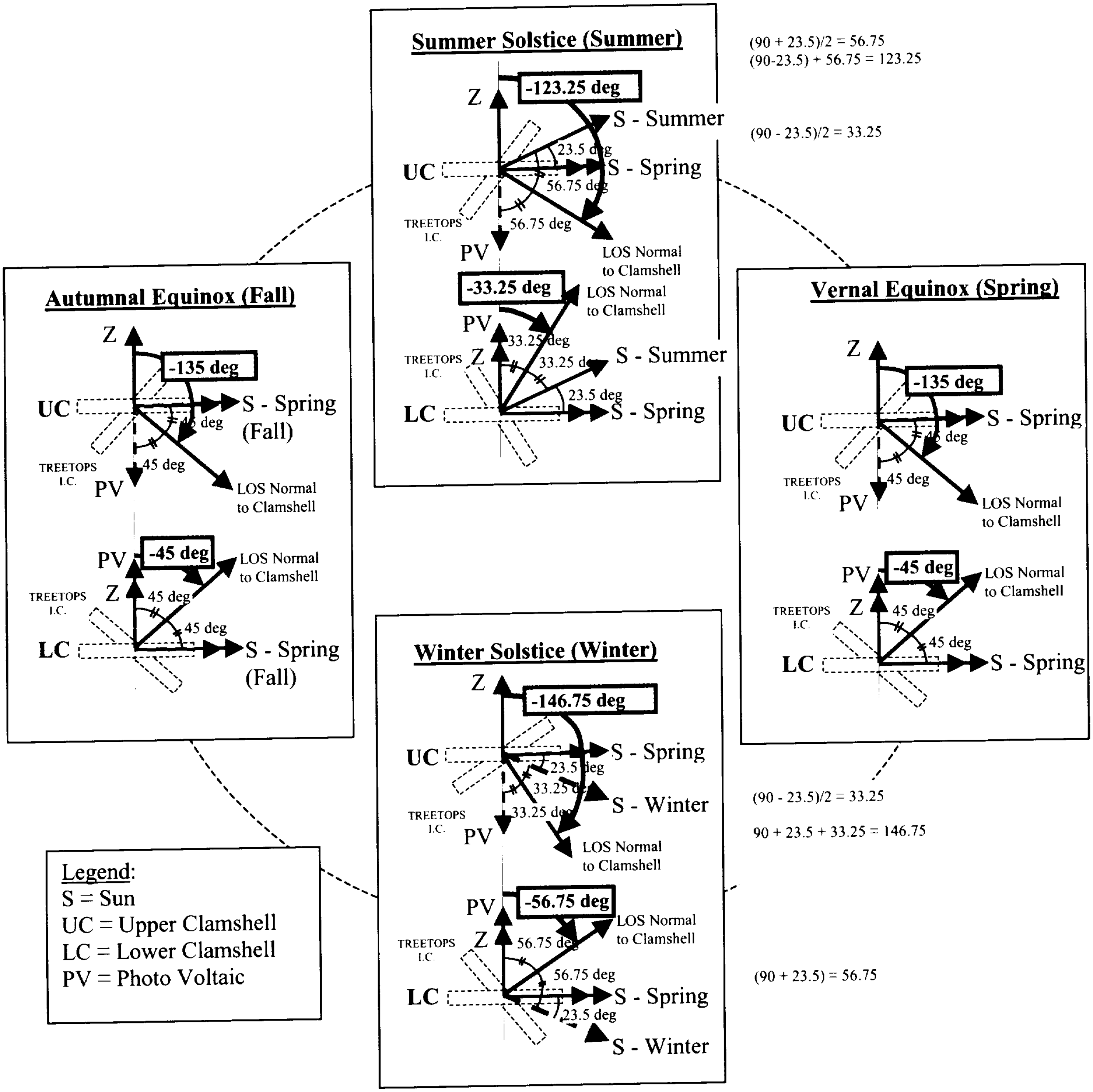


Figure A.6: Initial Condition Pitch Angles of the Upper and Lower Clamshells

Table A.1a: Initial Conditions in TREETOPS for Body 1 (Boom) and Body 2 (Central Body)
Concept 1, Concept 2A, Concept 2B and Concept 3

	Body 1 (Boom –Flexible)						Body 2 (Central Body – Rigid)					
Description	**H1** Free Rotational DOF between Body 0 (Earth) & Body 1 (Boom)	Reference axis for Euler Angles	Initial Euler Rotation Angles (deg) w.r.t geocentric origin in ECI CS	Initial Rotation Rate (deg/sec) w.r.t geocentric origin in ECI CS	Initial Translation (m) w.r.t. geocentric origin in ECI CS	Initial Translation Velocity (m/sec) w.r.t. geocentric origin in ECI CS	**H2** Free Rotational DOF between Body 1 (Boom) & Body 2 (Central Body)	Reference axis for Euler Angles	Initial Euler Rotation Angles (deg) w.r.t boom origin in boom CS	Initial Rotation Rate (deg/sec) w.r.t boom origin in boom CS	Initial Translation (m) w.r.t. boom origin in boom CS	Initial Translation Velocity (m/sec) w.r.t. boom origin in boom CS
Concept 1												
Vern Eq	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 0.	(0. 0. 0.)	(0. 0. R)	(v 0. 0.)	1- L1(Z^B)	L1(Z^B),L2(Y^B),L3(X^B)	90. 0. 0.	(ω)	(0. 0. 0.)	--
Sum Sol	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. 0.)	(0. 0. R)	(v 0. 0.)	1- L1(Z^B)	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	(ω)	(0. 0. 0.)	--
Autm Eq	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 180.	(0. 0. 0.)	(0. 0. R)	(v 0. 0.)	1- L1(Z^B)	L1(Z^B),L2(Y^B),L3(X^B)	-90. 0. 0.	(ω)	(0. 0. 0.)	--
Win Sol	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 270.	(0. 0. 0.)	(0. 0. R)	(v 0. 0.)	1- L1(Z^B)	L1(Z^B),L2(Y^B),L3(X^B)	180. 0. 0.	(ω)	(0. 0. 0.)	--
Concept 2A												
Vern Eq	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Sum Sol	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Autm Eq	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Win Sol	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Concept 2B												
Vern Eq	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Sum Sol	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Autm Eq	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Win Sol	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Concept 2C												
Vern Eq	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Sum Sol	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Autm Eq	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--
Win Sol	3- L1(X^I),L2(Y^I),L3(Z^I)	L1(X^I),L2(Y^I),L3(Z^I)	-90. 0. 90.	(0. 0. ω)	(0. 0. R)	(v 0. 0.)	0	L1(Z^B),L2(Y^B),L3(X^B)	0. 0. 0.	--	(0. 0. 0.)	--

Notes
1) Constants Used in Table:

$\omega = [1 + (1/365.25)][360 \text{ deg}/(24\text{hr} \times 3600 \text{ sec/hr})] = .004178$ deg/sec

R = 42163421. m

v = $2\pi R/86161.975 = 3074.681$ m/sec

I=ECI CS B=B1=Boom CS

Table A.1b: Initial Conditions in TREETOPS for Body 3 (Upper Clamshell) and Body 4 (Lower Clamshell) Concept 1, Concept 2A, Concept 2B and Concept 3

Body 3 (Upper Clamshell - Rigid)

Description	H3 Free Rotational DOF between Body 1 (Boom) & Body 3 (Upper Clamshell)	Reference axis for Euler Angles	Initial Euler Rotation Angles (deg) w.r.t boom origin in boom CS	Initial Rotation Rate (deg/sec) w.r.t boom origin in boom CS	Initial Trans-lation (m) w.r.t. boom origin in boom CS	ITV
Concept 1						
Vern Eq	0	$L1(Z^B),L2(X^B),L3(Y^B)$	~~0.~~ 0. -135.	--	(0. 0. 0.)	-
Sum Sol	0	$L1(Z^B),L2(X^B),L3(Y^B)$	90. 0. -123.25	--	(0. 0. 0.)	-
Autm Eq	0	$L1(Z^B),L2(X^B),L3(Y^B)$	~~180.~~ 0. -135.	--	(0. 0. 0.)	-
Win Sol	0	$L1(Z^B),L2(X^B),L3(Y^B)$	~~-90.~~ 0. -146.75	--	(0. 0. 0.)	-
Concept 2A						
Vern Eq	2- $L1(X^B),L2(Y^B)$	$L1(X^B),L2(Y^B),L3(Z^B)$	0. -135. 0.	(0. 0.)	(0. 0. 0.)	-
Sum Sol	2- $L1(X^B),L2(Y^B)$	$L1(X^B),L2(Y^B),L3(Z^B)$	123.25 0. 0.	(0. 0.)	(0. 0. 0.)	-
Autm Eq	2- $L1(X^B),L2(Y^B)$	$L1(X^B),L2(Y^B),L3(Z^B)$	0. 135. 0.	(0. 0.)	(0. 0. 0.)	-
Win Sol	2- $L1(X^B),L2(Y^B)$	$L1(X^B),L2(Y^B),L3(Z^B)$	-146.75 0. 0.	(0. 0.)	(0. 0. 0.)	-
Concept 2B						
Vern Eq	2- $L1(Z^B),L2(X^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	-90. 135. 0.	($-\omega$ 0.)	(0. 0. 0.)	-
Sum Sol	2- $L1(Z^B),L2(X^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	0. 123.25 0.	($-\omega$ 0.)	(0. 0. 0.)	-
Autm Eq	2- $L1(Z^B),L2(X^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	90. 135. 0.	($-\omega$ 0.)	(0. 0. 0.)	-
Win Sol	2- $L1(Z^B),L2(X^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	180. 146.75 0.	($-\omega$ 0.)	(0. 0. 0.)	-
Concept 2C						
Vern Eq	3- $L1(Z^B),L2(X^B),L3(Y^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	0. 0. -135.	($-\omega$ 0. 0.)	(0. 0. 0.)	-
Sum Sol	3- $L1(Z^B),L2(X^B),L3(Y^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	90. 0. -123.25	($-\omega$ 0. 0.)	(0. 0. 0.)	-
Autm Eq	3- $L1(Z^B),L2(X^B),L3(Y^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	180. 0. -135.	($-\omega$ 0. 0.)	(0. 0. 0.)	-
Win Sol	3- $L1(Z^B),L2(X^B),L3(Y^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	-90. 0. -146.75	($-\omega$ 0. 0.)	(0. 0. 0.)	-

Body 4 (Lower Clamshell – Rigid)

Description	H4 Free Rotational DOF between Body 1 (Boom) & Body 4 (Lower Clamshell)	Reference axis for Euler Angles	Initial Euler Rotation Angles (deg) w.r.t boom origin in boom CS	Initial Rotation Rate (deg/sec) w.r.t boom origin in boom CS	Initial Trans-lation (m) w.r.t. boom origin in boom CS	ITV
Concept 1						
Vern Eq	0	$L1(Z^B),L2(X^B),L3(Y^B)$	~~0.~~ 0. -45.	--	(0. 0. 0.)	-
Sum Sol	0	$L1(Z^B),L2(X^B),L3(Y^B)$	90. 0. -33.25	--	(0. 0. 0.)	-
Autm Eq	0	$L1(Z^B),L2(X^B),L3(Y^B)$	~~180.~~ 0. -45.	--	(0. 0. 0.)	-
Win Sol	0	$L1(Z^B),L2(X^B),L3(Y^B)$	~~-90.~~ 0. -56.75	--	(0. 0. 0.)	-
Concept 2A						
Vern Eq	2- $L1(X^B),L2(Y^B)$	$L1(X^B),L2(Y^B),L3(Z^B)$	0. -45. 0.	(0. 0.)	(0. 0. 0.)	-
Sum Sol	2- $L1(X^B),L2(Y^B)$	$L1(X^B),L2(Y^B),L3(Z^B)$	33.25 0. 0.	(0. 0.)	(0. 0. 0.)	-
Autm Eq	2- $L1(X^B),L2(Y^B)$	$L1(X^B),L2(Y^B),L3(Z^B)$	0. 45. 0.	(0. 0.)	(0. 0. 0.)	-
Win Sol	2- $L1(X^B),L2(Y^B)$	$L1(X^B),L2(Y^B),L3(Z^B)$	-56.75 0. 0.	(0. 0.)	(0. 0. 0.)	-
Concept 2B						
Vern Eq	2- $L1(Z^B),L2(X^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	-90. 45. 0.	($-\omega$ 0.)	(0. 0. 0.)	-
Sum Sol	2- $L1(Z^B),L2(X^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	0. 33.25 0.	($-\omega$ 0.)	(0. 0. 0.)	-
Autm Eq	2- $L1(Z^B),L2(X^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	90. 45. 0.	($-\omega$ 0.)	(0. 0. 0.)	-
Win Sol	2- $L1(Z^B),L2(X^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	180. 56.75 0.	($-\omega$ 0.)	(0. 0. 0.)	-
Concept 2C						
Vern Eq	3- $L1(Z^B),L2(X^B),L3(Y^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	0. 0. -45.	($-\omega$ 0. 0.)	(0. 0. 0.)	-
Sum Sol	3- $L1(Z^B),L2(X^B),L3(Y^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	90. 0. -33.25	($-\omega$ 0. 0.)	(0. 0. 0.)	-
Autm Eq	3- $L1(Z^B),L2(X^B),L3(Y^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	180. 0. -45.	($-\omega$ 0. 0.)	(0. 0. 0.)	-
Win Sol	3- $L1(Z^B),L2(X^B),L3(Y^B)$	$L1(Z^B),L2(X^B),L3(Y^B)$	-90. 0. -56.75	($-\omega$ 0. 0.)	(0. 0. 0.)	-

I=ECI CS B=B1=Boom CS

Notes
1) Constants Used in Table: :
$\omega = [1 + (1/365.25)][360 \text{ deg}/(24\text{hr} \times 3600 \text{ sec/hr})] = .004178$ deg/sec; R = 42163421. m; $v = 2\pi R/86161.975 = 3074.681$ m/sec
2) ITV - Initial Translation Velocity (m/sec) w.r.t. boom origin in boom CS
3) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 $L1(Z^B)$ should have been 90 deg for all cases.

A.1 Concept 1 Definitions and TREETOPS files

Sensor Definitions
Actuator Definitions
Interconnect Definitions
TREETOPS files:
Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx
Vernal Equinox (VE): .int
Autumnal Equinox (AE): .int
Winter Solstice (WS): .int

TableA.1.1 Sensor Definitions (Concept 1)

Global Sensor Output No.	TREETOPS Sensor Designation	Local Sensor Output No.	Sensor Mount Loc.	Type	used	DOF
RP 1	SE 1	1	B2-N2	Earth Target (ET) (LOS Along X^{B2})		Pitch (Y^{B2}) Error – Overall System (Central Body)
RP 2	SE 1	2	B2-N2			Yaw (Z^{B2}) Error – Overall System (Central Body)
RP 3	SE 2	1	B2-N2	Star Tracker (ST) (LOS Along Z^{B2})		Roll (X^{B2}) Error – Overall System (Central Body)
RP 4	SE 2	2	B2-N2			Not used in control (Pitch (Y^{B2}) Error) Central Body
RP 5	SE 2	3	B2-N2			Not used in control (Validity Flag on(1) off(0))
RP 6	SE 3	1	B1-N2	Star Tracker (ST) (LOS Along Y^{B1})		Yaw (Z^{B1}) Error – Boom
RP 7	SE 3	2	B1-N2			Not used in control, Roll (X^{B1}) Error – Boom
RP 8	SE 3	3	B1-N2			Validity Flag on(1) off(0) Used for Rad Pres Disturb
RP 9	SE 4	1	B1-N2	3 Axis Accelerometer (A3) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B1})
RP 10	SE 4	2	B1-N2			Not used in control, For Output Only, ACCEL (Y^{B1})
RP 11	SE 4	3	B1-N2			Not used in control, For Output Only, ACCEL (Z^{B1})
RP 12	SE 5	1	B1-N2	Local Vertical (LV) BJ_LVLH Transform Columns (Direction Cosine Matrix)		Not used in control, For Output Only, DCM (1,1)
RP 13	SE 5	2	B1-N2			Not used in control, For Output Only, DCM (2,1)
RP 14	SE 5	3	B1-N2			Not used in control, For Output Only, DCM (3,1)
RP 15	SE 5	4	B1-N2			Not used in control, For Output Only, DCM (1,2)
RP 16	SE 5	5	B1-N2			Not used in control, For Output Only, DCM (2,2)
RP 17	SE 5	6	B1-N2			Not used in control, For Output Only, DCM (3,2)
RP 18	SE 5	7	B1-N2			Not used in control, For Output Only, DCM (1,3)
RP 19	SE 5	8	B1-N2			Not used in control, For Output Only, DCM (2,3)
RP 20	SE 5	9	B1-N2			Not used in control, For Output Only, DCM (3,3)
RP 21	SE 6	1	B3-N2	LOS Sensor (L) (LOS Along $-Y^{I}$) (Negative Polar Axis) see .los file		Not used in control, Roll (X^{B3}) Error –UC
RP 22	SE 6	2	B3-N2			Not used in control, Pitch (Y^{B3}) Error – UC
RP 23	SE 6	3	B3-N2			Not used in control, Yaw (Z^{B3}) Error – UC
RP 24	SE 6	4	B3-N2			Not used in control
RP 25	SE 6	5	B3-N2			Not used in control
RP 26	SE 6	6	B3-N2			Not used in control
RP 27	SE 6	7	B3-N2			Not used in control
RP 28	SE 7	1	B4-N2	LOS Sensor (L) (LOS Along $+Y^{I}$) (Positive Polar Axis) see .los file		Not used in control, Roll (X^{B4}) Error – LC
RP 29	SE 7	2	B4-N2			Not used in control, Pitch (Y^{B4}) Error – LC
RP 30	SE 7	3	B4-N2			Not used in control, Yaw (Z^{B4}) Error – LC
RP 31	SE 7	4	B4-N2			Not used in control
RP 32	SE 7	5	B4-N2			Not used in control
RP 33	SE 7	6	B4-N2			Not used in control
RP 34	SE 7	7	B4-N2			Not used in control

Table A.1.2 Actuator Definitions (Concept 1)

Global Actuator Input No.	TREETOPS Actuator Designation	Sensor Mount Loc.	Type	DOF
UP 1	AC 1	B2-N2	Moment Actuator (MO)*	Pitch (Y^{B2}) Ext. Torque – Overall System (Central Body)
UP 2	AC 2	B2-N2	Moment Actuator (MO)*	Yaw (Z^{B2}) Ext. Torque – Overall System (Central Body)
UP 3	AC 3	B2-N2	Moment Actuator (MO)*	Roll (X^{B2}) Ext. Torque – Overall System (Central Body)
UP 4	AC 4	H2-A1	Motor Torque (T)**	Yaw (Z^{B1}) Torque, equal and opposite, on Boom/Central Body
UP 5	AC 5	B2-N5	Reaction Jet (J) Radiation Pressure Disturbance	$-X^{B2}$ Force at Central Body Transmitter

Notes:
* 1) Moment Actuator (MO) in TREETOPS is an External Moment applied to a Body (Reacts against Space) Used in Control
** 2) Motor Torque (T) in TREETOPS produces equal and opposite torques on the bodies adjacent to the hinge with the magnitude of the torque equal to the applied command level. A positive torque tends to increase the Euler angle associated with the mounting axis in a right hand sense.
3) H2-A1 is hinge 2 axis 1

Table A.1.3: Interconnect Data and Significant Parameters for TREETOPS Continuous Matrix (CM) Controller (Concept 1)

Interconnect Data						Significant Parameters in Continuous Matrix (CM) Controller in .lin file xdot = Ax + Bu y = Cx + Du			
Inter-connect	Description	S C C A	S No. C No. C No. A No.	S Out No. C In No. C Out No. A In No.	Gain N-m or N	Subset of A Matrix	Subset of B Matrix	Subset of C Matrix ω^2 $2\zeta\omega$	Subset of D Matrix
IC 1	Pitch (Y^{B2}) of Overall System	S	1	1	4.41E13	0. 1.	0	.000025 .007	0
		C	1	1					
IC 2		C	1	1	1.0	-1. -1.4	1		
		A	1	1					
IC 3	Yaw (Z^{B2}) of Overall System	S	1	2	1.67E12	0. 1.	0	.000025 .007	0
		C	1	2					
IC 4		C	1	2	1.0	-1. -1.4	1		
		A	2	1					
IC 5	Roll (X^{B2}) of Overall System	S	2	1	4.31E13	0. 1.	0	.000025 .007	0
		C	1	3					
IC 6		C	1	3	1.0	-1. -1.4	1		
		A	3	1					
IC 7	Yaw (Z^{B1}) of Boom	S	3	1	6.7E8	0. 1.	0	1.E-6 1.4E-3	0
		C	1	4					
IC 8		C	1	4	-1.0	-1. -1.4	1		
		A	4	1					
IC 9	$-X^{B2}$ of Radiation Pres Disturb	S	3	3	7.0				
		A	5	1					

isc3_flex_sol.int (Concept 1) Summer Solstice

```
TREETOPS REV 10P2  4/10/00

             SIM CONTROL

  1 SI    0 Title                                                  ISC MODEL, THIRD VERSION
  2 SI    0 Simulation stop time                                   100000
  3 SI    0 Plot data interval                                     20
  4 SI    0 Integration type (R,S,U, OR V)                         R
  5 SI    0 Step size (sec)                                        .1
  6 SI    0 Sandia ODE solver absolute and relative error
  7 SI    0 RK78 ODE solver absolute error and first step size
  8 SI    0 Linearization option   (L,Z or N)                      N
  9 SI    0 Restart option          (Y/N)                          N
 10 SI    0 Contact force computation option      (Y/N)            Y
 11 SI    0 Constraint force computation option   (Y/N)            N
 12 SI    0 Small angle speedup option (All,Bypass,First,Nth)      A
 13 SI    0 Mass matrix speedup option (All,Bypass,First,Nth)      A
 14 SI    0 Non-Linear  speedup option (All,Bypass,First,Nth)      A
 15 SI    0 Constraint  speedup option (All,Bypass,First,Nth)      A
 16 SI    0 Constraint stabilization option   (Y/N)                N
 17 SI    0 Stabilization epsilon

             GENGRAV

 18 GG    0 Gravity, earth sphere/nonsphere/user (S/N/U)?          N
 19 GG    1 Input gravity constants:  GME, ERAD, EMASS
 20 GG    1 Spherical or Nonspherical (S/N)?
 21 GG    1 Gravity Potential Harmonics J2,J3,J4
 22 GG    0 English (ft-slug-s) or metric (m-kg-s)     (E/M)?      M
 23 GG    0 Day, Month, Year,                                      20 6 2020
 24 GG    0 GMT @ sim time 0 (minutes past midnight,               360
 25 GG    0 Solar Pressure forces Y/N?                             Y
 26 GG    0 Input new data for aero model? (Y/N)                   N
 27 GG    1   Solar flux F10 for aero model
 28 GG    1   Solar flux, 81 day average F10B
 29 GG    1   Geomagnetic index, GEAP

             BODY

 30 BO    1 Body ID number                                         1
 31 BO    1 Type (Rigid,Flexible,NASTRAN)                          F
 32 BO    1 Number of modes                                        24
 33 BO    1 Modal calculation option (0, 1 or 2)                   2
 34 BO    1 Foreshortening option (Y/N)
 35 BO    1 Model reduction method (NO,MS,MC,CC,QM,CV)
 36 BO    1 NASTRAN data file FORTRAN unit number (40 - 60)
 37 BO    1 Number of augmented nodes (0 if none)
 38 BO    1 Damping matrix option (NS,CD,HL,SD)
 39 BO    1 Constant damping ratio
 40 BO    1 Low frequency, High frequency ratios
 41 BO    1 Mode ID number, damping ratio
 42 BO    1 Conversion factors: Length,Mass,Force
 43 BO    1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 44 BO    1 Moments of inertia (kg-m2) Ixx,Iyy,Izz                6.2852173E11 6.2852173E11
6.7057352E8
 45 BO    1 Products of inertia (kg-m2) Ixy,Ixz,Iyz                0 0 0
 46 BO    1 Mass (kg)                                              1.6168633E5
 47 BO    1 Number of Nodes                                        4
 48 BO    1 Node ID, Node coord. (meters) x,y,z                    1 0 0 0
 49 BO    1 Node ID, Node coord. (meters) x,y,z                    2 0 0 0
 50 BO    1 Node ID, Node coord. (meters) x,y,z                    3 0 0 3188.8
 51 BO    1 Node ID, Node coord. (meters) x,y,z                    4 0 0 -3188.8
 52 BO    1 Node ID, Node structual joint ID
```

```
 53 BO   2 Body ID number                                          2
 54 BO   2 Type (Rigid,Flexible,NASTRAN)                           R
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)  1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz               .8543E12 1.5601E12
1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0 0 0
 69 BO   2 Mass (kg)                                              12666300
 70 BO   2 Number of Nodes                                        5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                    1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                    2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                    3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                    4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                    5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                          3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                           R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)  1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz               1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0 0 0
 93 BO   3 Mass (kg)                                              2046600
 94 BO   3 Number of Nodes                                        2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                    1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                    2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                          4
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                           R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
110 BO   4 Conversion factors: Length,Mass,Force
111 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen)  1
112 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz               1.7E12 1.7E12 3.4E12
113 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0 0 0
114 BO   4 Mass (kg)                                              2046600
115 BO   4 Number of Nodes                                        2
116 BO   4 Node ID, Node coord. (meters) x,y,z                    1 0 0 0
117 BO   4 Node ID, Node coord. (meters) x,y,z                    2 0 0 0
118 BO   4 Node ID, Node structual joint ID
```

HINGE

119	HI	1	Hinge ID number	1
120	HI	1	Inboard body ID, Outboard body ID	0 1
121	HI	1	"p" node ID, "q" node ID	0 2
122	HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123	HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124	HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125	HI	1	L2 unit vector in inboard body coord. x,y,z	
126	HI	1	L2 unit vector in outboard body coord. x,y,z	
127	HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128	HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129	HI	1	Initial rotation angles (deg)	-90 0 90
130	HI	1	Initial rotation rates (deg/sec)	0 0 0
131	HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132	HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133	HI	1	Null torque angles (deg)	0 0 0
134	HI	1	Number of translation DOFs	3
135	HI	1	First translation unit vector g1	1 0 0
136	HI	1	Second translation unit vector g2	0 1 0
137	HI	1	Third translation unit vector g3	0 0 1
138	HI	1	Initial translation (meters)	0 0 42163421
139	HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140	HI	1	Translation stiffness (newtons/meters)	0 0 0
141	HI	1	Translation damping (newtons/meter/sec)	0 0 0
142	HI	1	Null force translations	0 0 0
143	HI	2	Hinge ID number	2
144	HI	2	Inboard body ID, Outboard body ID	1 2
145	HI	2	"p" node ID, "q" node ID	2 2
146	HI	2	Number of rotation DOFs	1
147	HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148	HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149	HI	2	L2 unit vector in inboard body coord. x,y,z	
150	HI	2	L2 unit vector in outboard body coord. x,y,z	
151	HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152	HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153	HI	2	Initial rotation angles (deg)	0 0 0
154	HI	2	Initial rotation rates (deg/sec)	0.00417807
155	HI	2	Rotation stiffness (newton-meters/rad)	0
156	HI	2	Rotation damping (newton-meters/rad/sec)	0
157	HI	2	Null torque angles (deg)	0
158	HI	2	Number of translation DOFs	0
159	HI	2	First translation unit vector g1	1 0 0
160	HI	2	Second translation unit vector g2	0 1 0
161	HI	2	Third translation unit vector g3	0 0 1
162	HI	2	Initial translation (meters)	0 0 0
163	HI	2	Initial translation velocity (meters/sec)	
164	HI	2	Translation stiffness (newtons/meters)	
165	HI	2	Translation damping (newtons/meter/sec)	
166	HI	2	Null force translations	
167	HI	3	Hinge ID number	3
168	HI	3	Inboard body ID, Outboard body ID	1 3
169	HI	3	"p" node ID, "q" node ID	3 2
170	HI	3	Number of rotation DOFs	0
171	HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172	HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173	HI	3	L2 unit vector in inboard body coord. x,y,z	
174	HI	3	L2 unit vector in outboard body coord. x,y,z	
175	HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176	HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177	HI	3	Initial rotation angles (deg)	90 0 -123.25
178	HI	3	Initial rotation rates (deg/sec)	
179	HI	3	Rotation stiffness (newton-meters/rad)	
180	HI	3	Rotation damping (newton-meters/rad/sec)	
181	HI	3	Null torque angles (deg)	
182	HI	3	Number of translation DOFs	0
183	HI	3	First translation unit vector g1	1 0 0
184	HI	3	Second translation unit vector g2	0 1 0

185	HI	3	Third translation unit vector g3	0 0 1
186	HI	3	Initial translation (meters)	0 0 0
187	HI	3	Initial translation velocity (meters/sec)	
188	HI	3	Translation stiffness (newtons/meters)	
189	HI	3	Translation damping (newtons/meter/sec)	
190	HI	3	Null force translations	
191	HI	4	Hinge ID number	4
192	HI	4	Inboard body ID, Outboard body ID	1 4
193	HI	4	"p" node ID, "q" node ID	4 2
194	HI	4	Number of rotation DOFs	0
195	HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196	HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197	HI	4	L2 unit vector in inboard body coord. x,y,z	
198	HI	4	L2 unit vector in outboard body coord. x,y,z	
199	HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200	HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201	HI	4	Initial rotation angles (deg)	90 0 -33.25
202	HI	4	Initial rotation rates (deg/sec)	
203	HI	4	Rotation stiffness (newton-meters/rad)	
204	HI	4	Rotation damping (newton-meters/rad/sec)	
205	HI	4	Null torque angles (deg)	
206	HI	4	Number of translation DOFs	0
207	HI	4	First translation unit vector g1	1 0 0
208	HI	4	Second translation unit vector g2	0 1 0
209	HI	4	Third translation unit vector g3	0 0 1
210	HI	4	Initial translation (meters)	0 0 0
211	HI	4	Initial translation velocity (meters/sec)	
212	HI	4	Translation stiffness (newtons/meters)	
213	HI	4	Translation damping (newtons/meter/sec)	
214	HI	4	Null force translations	

SENSOR

215	SE	1	Sensor ID number	1
216	SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217	SE	1	Mounting point body ID, Mounting point node ID	2 2
218	SE	1	Second mounting point body ID, Second node ID	
219	SE	1	Input axis unit vector (IA) x,y,z	
220	SE	1	Mounting point Hinge index, Axis index	
221	SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222	SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223	SE	1	Sun/Star unit vector (Us) x,y,z	
224	SE	1	Velocity Aberration Option (Y/N)	
225	SE	1	Euler Angle Sequence (1-6)	
226	SE	1	CMG ID number and Gimbal number	
227	SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228	SE	2	Sensor ID number	2
229	SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230	SE	2	Mounting point body ID, Mounting point node ID	2 2
231	SE	2	Second mounting point body ID, Second node ID	
232	SE	2	Input axis unit vector (IA) x,y,z	
233	SE	2	Mounting point Hinge index, Axis index	
234	SE	2	First focal plane unit vector (Fp1) x,y,z	0 -1 0
235	SE	2	Second focal plane unit vector (Fp2) x,y,z	1 0 0
236	SE	2	Sun/Star unit vector (Us) x,y,z	0 1 0
237	SE	2	Velocity Aberration Option (Y/N)	N
238	SE	2	Euler Angle Sequence (1-6)	
239	SE	2	CMG ID number and Gimbal number	
240	SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
241	SE	3	Sensor ID number	3
242	SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
243	SE	3	Mounting point body ID, Mounting point node ID	1 2
244	SE	3	Second mounting point body ID, Second node ID	
245	SE	3	Input axis unit vector (IA) x,y,z	
246	SE	3	Mounting point Hinge index, Axis index	
247	SE	3	First focal plane unit vector (Fp1) x,y,z	-1 0 0
248	SE	3	Second focal plane unit vector (Fp2) x,y,z	0 0 1

249	SE	3	Sun/Star unit vector (Us) x,y,z	0 0 0
250	SE	3	Velocity Aberration Option (Y/N)	N
251	SE	3	Euler Angle Sequence (1-6)	
252	SE	3	CMG ID number and Gimbal number	
253	SE	3	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254	SE	4	Sensor ID number	4
255	SE	4	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	A3
256	SE	4	Mounting point body ID, Mounting point node ID	1 2
257	SE	4	Second mounting point body ID, Second node ID	
258	SE	4	Input axis unit vector (IA) x,y,z	
259	SE	4	Mounting point Hinge index, Axis index	
260	SE	4	First focal plane unit vector (Fp1) x,y,z	
261	SE	4	Second focal plane unit vector (Fp2) x,y,z	
262	SE	4	Sun/Star unit vector (Us) x,y,z	
263	SE	4	Velocity Aberration Option (Y/N)	
264	SE	4	Euler Angle Sequence (1-6)	
265	SE	4	CMG ID number and Gimbal number	
266	SE	4	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
267	SE	5	Sensor ID number	5
268	SE	5	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	LV
269	SE	5	Mounting point body ID, Mounting point node ID	1 2
270	SE	5	Second mounting point body ID, Second node ID	
271	SE	5	Input axis unit vector (IA) x,y,z	
272	SE	5	Mounting point Hinge index, Axis index	
273	SE	5	First focal plane unit vector (Fp1) x,y,z	
274	SE	5	Second focal plane unit vector (Fp2) x,y,z	
275	SE	5	Sun/Star unit vector (Us) x,y,z	
276	SE	5	Velocity Aberration Option (Y/N)	
277	SE	5	Euler Angle Sequence (1-6)	
278	SE	5	CMG ID number and Gimbal number	
279	SE	5	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
280	SE	6	Sensor ID number	6
281	SE	6	Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	L
282	SE	6	Mounting point body ID, Mounting point node ID	3 2
283	SE	6	Second mounting point body ID, Second node ID	
284	SE	6	Input axis unit vector (IA) x,y,z	1 0 0
285	SE	6	Mounting point Hinge index, Axis index	
286	SE	6	First focal plane unit vector (Fp1) x,y,z	
287	SE	6	Second focal plane unit vector (Fp2) x,y,z	
288	SE	6	Sun/Star unit vector (Us) x,y,z	
289	SE	6	Velocity Aberration Option (Y/N)	
290	SE	6	Euler Angle Sequence (1-6)	
291	SE	6	CMG ID number and Gimbal number	
292	SE	6	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
293	SE	7	Sensor ID number	7
294	SE	7	Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	L
295	SE	7	Mounting point body ID, Mounting point node ID	4 2
296	SE	7	Second mounting point body ID, Second node ID	
297	SE	7	Input axis unit vector (IA) x,y,z	1 0 0
298	SE	7	Mounting point Hinge index, Axis index	
299	SE	7	First focal plane unit vector (Fp1) x,y,z	
300	SE	7	Second focal plane unit vector (Fp2) x,y,z	
301	SE	7	Sun/Star unit vector (Us) x,y,z	
302	SE	7	Velocity Aberration Option (Y/N)	
303	SE	7	Euler Angle Sequence (1-6)	
304	SE	7	CMG ID number and Gimbal number	
305	SE	7	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
			ACTR	
306	AC	1	Actuator ID number	1
307	AC	1	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308	AC	1	Actuator location; Node or Hinge (N or H)	
309	AC	1	Mounting point body ID number, node ID number	2 2
310	AC	1	Second mounting point body ID, second node ID	
311	AC	1	Output axis unit vector x,y,z	0 1 0

```
312 AC   1 Mounting point Hinge index, Axis index
313 AC   1 Rotor spin axis unit vector x,y,z
314 AC   1 Initial rotor momentum, H
315 AC   1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
316 AC   1 Outer gimbal axis unit vector x,y,z
317 AC   1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
318 AC   1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
319 AC   1 Inner gimbal axis unit vector x,y,z
320 AC   1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
321 AC   1 Initial length and rate, y(to) and ydot(to)
322 AC   1 Constants; K1 or wo, n or zeta, Kg, Jm
323 AC   1 Non-linearities; TLim, Tco, Dz

324 AC   2 Actuator ID number                                   2
325 AC   2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
326 AC   2 Actuator location; Node or Hinge (N or H)
327 AC   2 Mounting point body ID number, node ID number        2 2
328 AC   2 Second mounting point body ID, second node ID
329 AC   2 Output axis unit vector x,y,z                        0 0 1
330 AC   2 Mounting point Hinge index, Axis index
331 AC   2 Rotor spin axis unit vector x,y,z
332 AC   2 Initial rotor momentum, H
333 AC   2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
334 AC   2 Outer gimbal axis unit vector x,y,z
335 AC   2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
336 AC   2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
337 AC   2 Inner gimbal axis unit vector x,y,z
338 AC   2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
339 AC   2 Initial length and rate, y(to) and ydot(to)
340 AC   2 Constants; K1 or wo, n or zeta, Kg, Jm
341 AC   2 Non-linearities; TLim, Tco, Dz

342 AC   3 Actuator ID number                                   3
343 AC   3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
344 AC   3 Actuator location; Node or Hinge (N or H)
345 AC   3 Mounting point body ID number, node ID number        2 2
346 AC   3 Second mounting point body ID, second node ID
347 AC   3 Output axis unit vector x,y,z                        1 0 0
348 AC   3 Mounting point Hinge index, Axis index
349 AC   3 Rotor spin axis unit vector x,y,z
350 AC   3 Initial rotor momentum, H
351 AC   3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
352 AC   3 Outer gimbal axis unit vector x,y,z
353 AC   3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
354 AC   3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
355 AC   3 Inner gimbal axis unit vector x,y,z
356 AC   3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
357 AC   3 Initial length and rate, y(to) and ydot(to)
358 AC   3 Constants; K1 or wo, n or zeta, Kg, Jm
359 AC   3 Non-linearities; TLim, Tco, Dz

360 AC   4 Actuator ID number                                   4
361 AC   4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  T
362 AC   4 Actuator location; Node or Hinge (N or H)
363 AC   4 Mounting point body ID number, node ID number
364 AC   4 Second mounting point body ID, second node ID
365 AC   4 Output axis unit vector x,y,z
366 AC   4 Mounting point Hinge index, Axis index               2 1
367 AC   4 Rotor spin axis unit vector x,y,z
368 AC   4 Initial rotor momentum, H
369 AC   4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
370 AC   4 Outer gimbal axis unit vector x,y,z
371 AC   4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
372 AC   4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
373 AC   4 Inner gimbal axis unit vector x,y,z
374 AC   4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
375 AC   4 Initial length and rate, y(to) and ydot(to)
376 AC   4 Constants; K1 or wo, n or zeta, Kg, Jm
377 AC   4 Non-linearities; TLim, Tco, Dz

378 AC   5 Actuator ID number                                   5
```

379	AC	5	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
380	AC	5	Actuator location; Node or Hinge (N or H)	
381	AC	5	Mounting point body ID number, node ID number	2 5
382	AC	5	Second mounting point body ID, second node ID	
383	AC	5	Output axis unit vector x,y,z	-1 0 0
384	AC	5	Mounting point Hinge index, Axis index	
385	AC	5	Rotor spin axis unit vector x,y,z	
386	AC	5	Initial rotor momentum, H	
387	AC	5	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388	AC	5	Outer gimbal axis unit vector x,y,z	
389	AC	5	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390	AC	5	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391	AC	5	Inner gimbal axis unit vector x,y,z	
392	AC	5	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393	AC	5	Initial length and rate, y(to) and ydot(to)	
394	AC	5	Constants; K1 or wo, n or zeta, Kg, Jm	
395	AC	5	Non-linearities; TLim, Tco, Dz	

CONTROLLER

396	CO	1	Controller ID number	1
397	CO	1	Controller type (CB,CM,DB,DM,UC,UD)	CM
398	CO	1	Sample time (sec)	
399	CO	1	Number of inputs, Number of outputs	4 4
400	CO	1	Number of states	
401	CO	1	Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

402	IN	1	Interconnect ID number	1
403	IN	1	Source type(S,C, or F),Source ID,Source row #	S 1 1
404	IN	1	Destination type(A or C),Dest ID,Dest row #	C 1 1
405	IN	1	Gain	4.41E13
406	IN	2	Interconnect ID number	2
407	IN	2	Source type(S,C, or F),Source ID,Source row #	C 1 1
408	IN	2	Destination type(A or C),Dest ID,Dest row #	A 1 1
409	IN	2	Gain	1
410	IN	3	Interconnect ID number	3
411	IN	3	Source type(S,C, or F),Source ID,Source row #	S 1 2
412	IN	3	Destination type(A or C),Dest ID,Dest row #	C 1 2
413	IN	3	Gain	1.67E12
414	IN	4	Interconnect ID number	4
415	IN	4	Source type(S,C, or F),Source ID,Source row #	C 1 2
416	IN	4	Destination type(A or C),Dest ID,Dest row #	A 2 1
417	IN	4	Gain	1
418	IN	5	Interconnect ID number	5
419	IN	5	Source type(S,C, or F),Source ID,Source row #	S 2 1
420	IN	5	Destination type(A or C),Dest ID,Dest row #	C 1 3
421	IN	5	Gain	4.31E13
422	IN	6	Interconnect ID number	6
423	IN	6	Source type(S,C, or F),Source ID,Source row #	C 1 3
424	IN	6	Destination type(A or C),Dest ID,Dest row #	A 3 1
425	IN	6	Gain	1
426	IN	7	Interconnect ID number	7
427	IN	7	Source type(S,C, or F),Source ID,Source row #	S 3 1
428	IN	7	Destination type(A or C),Dest ID,Dest row #	C 1 4
429	IN	7	Gain	6.7E8
430	IN	8	Interconnect ID number	8
431	IN	8	Source type(S,C, or F),Source ID,Source row #	C 1 4
432	IN	8	Destination type(A or C),Dest ID,Dest row #	A 4 1
433	IN	8	Gain	1

```
434 IN   9 Interconnect ID number                                   9
435 IN   9 Source type(S,C, or F),Source ID,Source row #            S 3 3
436 IN   9 Destination type(A or C),Dest ID,Dest row #              A 5 1
437 IN   9 Gain                                                     7
```

isc3_flex_sol.lin (Concept 1) 'Summer Solstice

```
* Controller for integrated symmetrical concentrator
system CONT1 8,4,4,0,0,0.0
*A
0 1 0 0 0 0 0 0
-1 -1.4 0 0 0 0 0 0
0 0 0 1 0 0 0 0
0 0 -1 -1.4 0 0 0 0
0 0 0 0 0 1 0 0
0 0 0 0 -1 -1.4 0 0
0 0 0 0 0 0 0 1
0 0 0 0 0 0 -1 -1.4
*B
0 0 0 0
1 0 0 0
0 0 0 0
0 1 0 0
0 0 0 0
0 0 1 0
0 0 0 0
0 0 0 1
*C
.000025 .007  0 0 0 0 0 0
0 0 .000025 .007 0 0 0 0
0 0 0 0 .000025 .007 0 0
0 0 0 0 0 0 1e-2 1.4e-1
*D
0 0 0 0
0 0 0 0
0 0 0 0
0 0 0 0
*H
*M
```

los.dat (Concept 1) Summer Solstice

```
6,              ! Sensor number of 1st FGS (clamshell) sensor
0.d0,0.d0,0.d0,         ! Defaults to sun as a target for zero input vector
0.d0, -1.d0,0.d0,       ! Target star along negative polar axis
0.d0,-1.d0,0.d0,        ! Focal plane vector 1
1.d0,0.d0,0.d0,         ! Focal plane vector 2
1.d0,0.d0,0.d0,         ! Focal plane vector 3

 7,             ! Sensor number of 2nd FGS (clamshell) sensor
0.d0,0.d0,0.d0,         ! Defaults to sun as a target for zero input vector
0.d0, 1.d0,0.d0,        ! Target star along positive polar axis
0.d0,-1.d0,0.d0,        ! Focal plane vector 1
1.d0,0.d0,0.d0,         ! Focal plane vector 2
-1.d0,0.d0,0.d0,        ! Focal plane vector 3
```

solar_pressure.dat (Concept 1) Summer Solstice

```
22, 'm',        ! number of panels, units English or Metric ***Updated 11/15/00***
1,2,638000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,-7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,-7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0, 0.1736d0,0.d0,0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0, -0.1736d0,1.d0,-0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0, 0.1736d0,0.d0,-0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0, -0.1736d0,-1.d0,0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0, 1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,     ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,     ! body, node, area, reflectivity factor,outward normal,centroid
```

isc3_flex_sol.flx (Concept 1) Summer Solstice (An excerpt)

```
flag, revision number
XXXXXX          1
  body id
      1
  modes, nodes, modal options
     24       4       0       0       0       0       0       0
      0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0
  phi_t for node #         2
  .31310941E-02 -.16357954E-03  .19158607E-08  .68659216E-04  .31346273E-02
  .14949358E-08 -.33409338E-09 -.17910070E-08 -.62130721E-04  .10048928E-08
  .74260327E-10 -.81693812E-09  .66744219E-10 -.57300403E-09  .56292416E-10
 -.31109642E-09  .51999889E-08  .41569313E-10  .36697769E-02  .69502051E-03
  .85567197E-10 -.10557893E-02  .35826871E-02  .65924560E-10  .61553749E-10
  .11085623E-08 -.67301328E-05  .49549244E-10 -.49437998E-08 -.60865848E-11
  .10484816E-08  .39239830E-10 -.17858973E-09  .46440350E-10  .23145265E-09
  .76239104E-11 -.98486197E-09 -.52382674E-09  .30708566E-12  .12143532E-10
 -.10722701E-09  .94529479E-03  .17735129E-08  .15323995E-09  .13868812E-12
 -.13390485E-02 -.55272105E-04 -.82202021E-12  .55317399E-04 -.13390483E-02
  .27552836E-11  .29149021E-10 -.27567962E-12 -.44865972E-10  .48584658E-11
  .10595799E-10 -.31919479E-08 -.19937738E-10  .14255509E-09 -.23770452E-02
 -.45933446E-03 -.19673179E-04  .63985161E-12 -.19675549E-04  .45933391E-03
 -.74265281E-12 -.34874105E-11 -.12587102E-11  .59687765E-09 -.12099360E-11
 -.69004494E-11  .19524343E-08
  phi_t prime for node #         2
  .17177767E-11 -.22808543E-11 -.45683561E-10  .19817016E-10  .56718933E-12
  .31514104E-09  .17463000E-11 -.27057756E-13 -.60467460E-12  .11400599E-06
 -.42543750E-05 -.11919737E-10  .42546793E-05  .10153760E-06 -.34352434E-10
  .41859459E-11 -.37080794E-11  .59234151E-04  .45504345E-11 -.70844966E-12
  .15588470E-10  .13593377E-10  .68741697E-12  .87795145E-10 -.28497036E-11
  .31909564E-13 -.69421743E-15  .38765922E-11 -.41335440E-11 -.44983453E-04
  .22473012E-05 -.13022411E-04  .41075666E-11 -.13101519E-04 -.17274113E-05
 -.98017672E-11 -.14778531E-12 -.42275125E-13 -.96071643E-06 -.25440820E-11
  .54200130E-11  .41425181E-12 -.51084189E-13  .98880082E-15  .14899414E-06
 -.49351318E-14  .15066380E-14 -.42969795E-10 -.54223125E-14  .27635772E-15
 -.79851673E-11  .23444071E-06 -.40722409E-05 -.13017710E-13  .40722809E-05
  .23382333E-06  .64327760E-12 -.80030821E-11  .19070818E-11  .27557384E-13
  .67193209E-14  .15459451E-13  .15489036E-10  .28188639E-13  .15021236E-15
  .22611633E-11 -.61243211E-07  .17482812E-05  .30019490E-13 -.17482739E-05
 -.61449314E-07 -.27684414E-12
  phi_t for node #         3
 -.42404714E-02  .49480955E-03  .19835813E-08 -.36612814E-03 -.42534660E-02
  .96750031E-09  .42209027E-09  .30963712E-08  .40516924E-04  .38549281E-02
 -.52714285E-03 -.87737477E-09  .53843743E-03  .38533672E-02 -.10363838E-09
  .38623427E-08 -.71743451E-08  .24131659E-03  .31427071E-02 -.10270931E-03
  .15812594E-09 -.20969267E-03  .31373775E-02  .44642715E-09  .28790083E-09
  .88009461E-09  .18408168E-03 -.17813513E-08 -.27431844E-08  .15957166E-04
 -.19242852E-02  .34087019E-03 -.22330623E-09  .41716037E-03  .19091971E-02
 -.71605887E-10  .95016675E-09 -.81490514E-09  .32861442E-02 -.18116747E-08
  .55541036E-09  .79551900E-03 -.41608643E-08 -.26069981E-09  .94036451E-02
  .21682867E-02 -.12127210E-02  .85710915E-08  .12126479E-02  .21683282E-02
 -.39141685E-08  .18971552E-02 -.12009168E-02  .43705940E-08  .12012029E-02
  .18969745E-02  .16937062E-07 -.67726532E-08 -.66549206E-08  .11440634E-01
  .49982895E-02 -.24804966E-02  .39527267E-09 -.24804686E-02 -.49983050E-02
 -.34622476E-08 -.50056020E-02  .25440974E-02 -.23331468E-08 -.25435047E-02
 -.50059046E-02 -.85708461E-08
  phi_t prime for node #         3
 -.50525028E-06 -.31564387E-05 -.80521842E-10  .31702786E-05 -.40940183E-06
  .57389171E-09 -.26678138E-11  .65900274E-12 -.58046889E-04  .10244708E-05
  .47674564E-05  .15531760E-10 -.47644389E-05  .10384376E-05  .44257276E-10
  .11200572E-10  .49389619E-11 -.61429724E-04  .68382965E-06  .54576833E-05
 -.20073106E-10 -.54985919E-05  .13880871E-06 -.11950858E-09 -.12906028E-11
  .35486701E-12 -.77274292E-04  .61171041E-11 -.56114520E-11 -.65377923E-04
 -.17172111E-05 -.54788611E-05  .24079039E-11 -.54062017E-05  .19338345E-05
  .41797610E-11  .67570000E-11  .20000043E-10  .51675836E-06 -.99163146E-11
 -.24536147E-10  .16113741E-05 -.24387637E-10 -.45291231E-10  .14474359E-04
  .40550997E-04  .55846277E-04 -.22605263E-10 -.55847708E-04  .40549096E-04
 -.12064872E-11  .40806300E-04  .51925447E-04 -.22326921E-10 -.51919351E-04
```

```
 .40814113E-04  .35521932E-10  .15828591E-09 -.16771401E-09  .21209458E-04
 .16987298E-03  .27619447E-03  .11975439E-09  .27619558E-03 -.16987148E-03
-.57982074E-10 -.17376694E-03 -.27781790E-03 -.11765510E-09  .27783862E-03
-.17373409E-03 -.70075300E-10
 phi_t for node #          4
-.42404802E-02  .49480360E-03  .18585028E-08 -.36612933E-03 -.42535396E-02
 .21036956E-08  .39723035E-09 -.14786269E-09  .40516905E-04 -.38549306E-02
 .52714303E-03 -.77214743E-09 -.53843745E-03 -.38533660E-02  .20798890E-09
-.73886299E-08 -.15978809E-07 -.24131650E-03  .31427093E-02 -.10270436E-03
 .13801450E-10 -.20968938E-03  .31373931E-02 -.39914612E-09  .41931685E-11
 .99616139E-10  .18408168E-03  .35438059E-09 -.17390277E-08 -.15957178E-04
 .19242857E-02 -.34087031E-03 -.23866856E-09 -.41716036E-03 -.19091972E-02
-.19395891E-10  .94356214E-09 -.84924469E-09 -.32861442E-02  .18078300E-08
-.56604075E-09  .79551900E-03 -.41738415E-08 -.28114281E-09 -.94036451E-02
 .21682868E-02 -.12127209E-02 -.85410786E-08  .12126480E-02  .21683284E-02
 .38256346E-08 -.18971552E-02  .12009169E-02  .43704936E-08 -.12012030E-02
-.18969746E-02  .17005110E-07  .67789071E-08  .66775796E-08  .11440634E-01
 .49982897E-02 -.24804968E-02 -.39492666E-09 -.24804688E-02 -.49983053E-02
 .34827434E-08  .50056020E-02 -.25440973E-02 -.23324836E-08  .25435049E-02
 .50059050E-02 -.85841247E-08
 phi_t prime for node #          4
 .50524725E-06  .31564441E-05 -.82070494E-10 -.31703213E-05  .40940604E-06
 .62154334E-09  .34011412E-12 -.27858908E-12  .58046878E-04  .10244712E-05
 .47674599E-05  .13355611E-10 -.47644372E-05  .10384375E-05  .44054122E-10
-.22077045E-10  .11247290E-10 -.61429722E-04 -.68382100E-06 -.54576879E-05
-.24245181E-10  .54986198E-05 -.13881681E-06 -.15347238E-09  .50958361E-12
-.41824742E-12  .77274292E-04 -.42833617E-11  .34928804E-12 -.65377921E-04
-.17172117E-05 -.54788625E-05  .15891701E-11 -.54062019E-05  .19338345E-05
-.90655410E-11 -.71395520E-11 -.19852937E-10  .51675837E-06 -.10061491E-10
-.24464605E-10 -.16113739E-05  .23986931E-10  .45635598E-10  .14474359E-04
-.40550995E-04 -.55846279E-04 -.22604313E-10  .55847713E-04 -.40549100E-04
-.14851140E-11  .40806300E-04  .51925447E-04  .22357522E-10 -.51919354E-04
 .40814116E-04 -.35835384E-10  .15906312E-09 -.16795738E-09 -.21209458E-04
-.16987299E-03 -.27619447E-03  .11979215E-09 -.27619560E-03  .16987149E-03
-.57726900E-10 -.17376694E-03 -.27781789E-03  .11764036E-09  .27783864E-03
-.17373411E-03  .70185849E-10
 mass matrix
 .10000000E+01 -.30291562E-01 -.76876291E-07  .73800796E-06  .32867117E-06
 .13158549E-06 -.92633251E-08 -.17952422E-07  .62673968E-08 -.19995321E-07
 .20953681E-06 -.61379992E-07  .12006683E-09 -.11753664E-09  .88805322E-10
 .18582751E-09  .93589593E-10  .34601899E-08  .12520782E-08  .51220876E-10
-.26895388E-10 -.46932083E-10 -.51456416E-09 -.16699282E-09 -.30291562E-01
 .10000000E+01  .26989693E-07  .24701420E-07  .34123181E-05  .19569915E-07
 .18126030E-07 -.22083024E-07 -.30895835E-08 -.63797417E-09  .13846796E-06
-.91584230E-06  .28463240E-09 -.92291186E-09  .13196997E-09 -.83498605E-10
-.23061102E-09  .37066771E-09  .14015707E-07  .71524564E-09 -.97352491E-12
-.79781628E-10 -.28504651E-10 -.24628018E-08 -.76876291E-07  .26989693E-07
 .10000000E+01 -.12820039E-07  .23873133E-06  .46502856E-07  .48615925E-08
-.31587180E-08 -.94997621E-10 -.56075172E-08  .49113872E-08 -.51914907E-07
-.57636964E-11  .45511296E-10  .45041193E-11 -.28608624E-10  .92163317E-11
-.16290986E-10  .76859350E-09 -.31071312E-10 -.47158520E-11 -.13956592E-11
 .40931813E-11 -.13308932E-09  .73800796E-06  .24701420E-07 -.12820039E-07
 .10000000E+01  .29302137E-02  .10572523E-05 -.24430484E-06  .68476034E-07
 .92720426E-09 -.64534578E-07  .16242822E-07  .86600013E-08  .72440444E-09
 .16245107E-08 -.11209088E-09  .55930229E-10 -.44166054E-09 -.10256621E-08
-.50144862E-09 -.15880740E-08  .25789654E-09 -.98514653E-10 -.37720327E-09
 .27460623E-09  .32867117E-06  .34123181E-05  .23873133E-06  .29302137E-02
 .10000000E+01  .71189247E-06 -.53815780E-06 -.15566832E-05  .83251907E-07
-.45009419E-07 -.44807150E-07  .17705875E-07 -.16602525E-08 -.43070508E-08
-.20692528E-09  .20019442E-08  .57241159E-08 -.72556163E-09  .93151063E-09
 .18206492E-08 -.13561118E-09 -.12897281E-08 -.25829052E-10  .16156569E-09
 .13158549E-06  .19569915E-07  .46502856E-07  .10572523E-05  .71189247E-06
 .10000000E+01 -.83160269E-07  .24349543E-07  .11233865E-07  .10028917E-06
-.12313102E-06  .70134651E-07 -.13207290E-08  .28173844E-08 -.11660397E-08
 .22882173E-09 -.30171128E-09 -.14728997E-08 -.13109908E-08  .32317686E-09
 .12105915E-10 -.55168990E-10  .27914248E-09  .14656790E-09 -.92633250E-08
 .18126030E-07  .48615925E-08 -.24430484E-06 -.53815780E-06 -.83160269E-07
 .10000000E+01 -.99242756E-01  .22394316E-07 -.39958298E-07  .32234509E-06
-.50160922E-06  .23636843E-09 -.21910738E-09  .14348669E-09  .15847338E-09
 .74774558E-10  .32733302E-08  .57239272E-08  .10031900E-09 -.36640911E-10
-.81560611E-10 -.45187655E-09 -.93057423E-09 -.17952422E-07 -.22083024E-07
```

-.31587180E-08	.68476034E-07	-.15566832E-05	.24349543E-07	-.99242756E-01
.10000000E+01	-.20074054E-07	.16458235E-07	.15485050E-06	-.15630944E-05
.29386609E-09	-.10163269E-08	.11846928E-09	-.20501990E-09	-.41770205E-09
-.56246450E-09	.16797163E-07	.78252621E-09	.33675344E-11	-.57812240E-10
.11108613E-09	-.29422473E-08	.62673968E-08	-.30895835E-08	-.94997760E-10
.92720426E-09	.83251907E-07	.11233865E-07	.22394316E-07	-.20074054E-07
.10000000E+01	.12712850E-07	-.23627686E-07	.15204590E-06	.96068819E-11
-.66710239E-10	-.23527708E-12	.57865057E-10	-.34048646E-10	-.56274547E-10
-.13467924E-08	.57321148E-10	.72512622E-11	.43261077E-11	.42475879E-11
.23009307E-09	-.19995321E-07	-.63797417E-09	-.56075174E-08	-.64534578E-07
-.45009419E-07	.10028917E-06	-.39958298E-07	.16458235E-07	.12712850E-07
.10000000E+01	.34013758E-06	-.19456390E-06	.12276100E-08	-.23143374E-08
.90995226E-09	-.20703316E-09	.26711414E-09	.17484259E-08	.14384415E-08
-.22089987E-09	-.12869248E-10	.38339013E-10	-.31448481E-09	-.18544250E-09
.20953681E-06	.13846796E-06	.49113872E-08	.16242822E-07	-.44807150E-07
-.12313102E-06	.32234509E-06	.15485050E-06	-.23627686E-07	.34013758E-06
.10000000E+01	-.39786267E-01	.17049808E-08	.38885439E-08	-.46588188E-09
.12616452E-08	.13318808E-08	-.42894021E-08	.74108288E-09	-.45855306E-08
.76304756E-09	-.90324773E-09	-.10747486E-08	.61285555E-09	-.61379992E-07
-.91584230E-06	-.51914907E-07	.86600013E-08	.17705875E-07	.70134651E-07
-.50160922E-06	-.15630944E-05	.15204590E-06	-.19456390E-06	-.39786267E-01
.10000000E+01	.62505978E-08	.15167020E-07	.64225500E-09	-.64493380E-08
-.19359751E-07	.14627884E-08	-.39742767E-08	-.61200326E-08	.51696455E-09
.41021165E-08	.38755886E-10	-.28087086E-09	.12006683E-09	.28463240E-09
-.57637523E-11	.72440444E-09	-.16602525E-08	-.13207290E-08	.23636843E-09
.29386609E-09	.96069199E-11	.12276100E-08	.17049808E-08	.62505978E-08
.10000000E+01	.73552646E-10	.38814802E-10	.36872491E-10	.72462767E-10
-.30908303E-09	.78347194E-09	-.80736378E-10	.38873326E-11	-.52248843E-11
.43195040E-10	-.10247581E-09	-.11753664E-09	-.92291186E-09	.45511310E-10
.16245107E-08	-.43070508E-08	.28173844E-08	-.21910738E-09	-.10163269E-08
-.66710219E-10	-.23143374E-08	.38885439E-08	.15167020E-07	.73552316E-10
.10000000E+01	-.15617476E-09	-.61749360E-11	-.26777146E-09	-.10599770E-08
.29161646E-08	-.20094998E-09	.18211917E-10	.26472063E-10	.16702574E-09
-.34247066E-09	.88805322E-10	.13196997E-09	.45041462E-11	-.11209088E-09
-.20692528E-09	-.11660397E-08	.14348669E-09	.11846928E-09	-.23525973E-12
.90995225E-09	-.46588188E-09	.64225500E-09	.38814889E-10	-.15617482E-09
.10000000E+01	.12187317E-09	.15001747E-09	.24640744E-09	.42025294E-09
-.18289440E-09	.56313574E-11	-.72942198E-11	-.17559408E-10	-.32344202E-10
.18582743E-09	-.83498576E-10	-.28608624E-10	.55930264E-10	.20019442E-08
.22882173E-09	.15847327E-09	-.20501985E-09	.57865057E-10	-.20703316E-09
.12616453E-08	-.64493380E-08	.36872491E-10	-.61749360E-11	.12187317E-09
.10000000E+01	-.32661816E-04	-.43944057E-08	-.24952357E-07	.81538381E-10
.34212335E-10	.38356819E-10	.24612814E-10	.46331501E-09	.93589566E-10
-.23061114E-09	.92163317E-11	-.44166048E-09	.57241158E-08	-.30171128E-09
.74774490E-10	-.41770205E-09	-.34048646E-10	.26711414E-09	.13318808E-08
-.19359751E-07	.72462767E-10	-.26777146E-09	.15001747E-09	-.32661816E-04
.10000000E+01	.42300905E-08	-.73197671E-07	-.10441846E-08	-.14602376E-11
.73313057E-10	-.10191802E-09	.14986050E-08	.34601900E-08	.37066776E-09
-.16290986E-10	-.10256622E-08	-.72556165E-09	-.14728997E-08	.32733303E-08
-.56246452E-09	-.56274547E-10	.17484259E-08	-.42894022E-08	.14627883E-08
-.30908303E-09	-.10599770E-08	.24640744E-09	-.43944057E-08	.42300905E-08
.10000000E+01	.15221368E-03	-.86338705E-08	.45921228E-09	-.20521056E-09
-.89116174E-09	.26024348E-09	.12520782E-08	.14015707E-07	.76859350E-09
-.50144861E-09	.93151061E-09	-.13109908E-08	.57239273E-08	.16797163E-07
-.13467924E-08	.14384415E-08	.74108288E-09	-.39742767E-08	.78347194E-09
.29161646E-08	.42025294E-09	-.24952357E-07	-.73197671E-07	.15221368E-03
.10000000E+01	.96863908E-08	-.22080642E-09	-.21316144E-08	-.16738301E-09
.50310155E-09	.51220876E-10	.71524564E-09	-.31071253E-10	-.15880740E-08
.18206492E-08	.32317686E-09	.10031900E-09	.78252621E-09	.57321209E-10
-.22089988E-09	-.45855306E-08	-.61200326E-08	-.80736291E-10	-.20094994E-09
-.18289443E-09	.81538381E-10	-.10441846E-08	-.86338705E-08	.96863908E-08
.10000000E+01	-.83286638E-10	-.96200651E-10	-.75748973E-09	.64933845E-09
-.26895791E-10	-.97338757E-12	-.47158520E-11	.25789669E-09	-.13561120E-09
.12105915E-10	-.36641097E-10	.33675814E-11	.72512622E-11	-.12869248E-10
.76304768E-09	.51696454E-09	.38873326E-11	.18211917E-10	.56313574E-11
.34212015E-10	-.14603011E-11	.45921242E-09	-.22080646E-09	-.83286638E-10
.10000000E+01	.58959486E-05	.14665321E-07	-.85539216E-08	-.46932053E-10
-.79781317E-10	-.13956592E-11	-.98514661E-10	-.12897281E-08	-.55168990E-10
-.81560497E-10	-.57812195E-10	.43261077E-11	.38339013E-10	-.90324783E-09
.41021164E-08	-.52248843E-11	.26472063E-10	-.72942198E-11	.38356856E-10
.73313071E-10	-.20521064E-09	-.21316143E-08	-.96200651E-10	.58959486E-05

.10000000E+01	-.59777300E-08	-.75550117E-07	-.51456404E-09	-.28504694E-10
.40931813E-11	-.37720340E-09	-.25829159E-10	.27914248E-09	-.45187665E-09
.11108611E-09	.42475879E-11	-.31448481E-09	-.10747487E-08	.38755748E-10
.43195040E-10	.16702574E-09	-.17559408E-10	.24612970E-10	-.10191791E-09
-.89116176E-09	-.16738308E-09	-.75748973E-09	.14665321E-07	-.59777301E-08
.10000000E+01	-.11866292E-03	-.16699269E-09	-.24628016E-08	-.13308932E-09
.27460630E-09	.16156571E-09	.14656790E-09	-.93057434E-09	-.29422474E-08
.23009307E-09	-.18544250E-09	.61285545E-09	-.28087069E-09	-.10247581E-09
-.34247066E-09	-.32344202E-10	.46331502E-09	.14986050E-08	.26024357E-09
.50310165E-09	.64933845E-09	-.85539216E-08	-.75550117E-07	-.11866292E-03
.10000000E+01				

damping matrix

.01975800E-00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.01975800E-00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.02852600E-00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.51561286E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.51561345E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.58615570E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.18482064E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.18482067E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.21730454E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.26395027E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.33015249E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.33015287E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00

```
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .85110374E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .96499772E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .12323587E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14322839E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14322847E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14874285E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14874293E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .16365219E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23335965E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23335978E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23420770E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23420782E+00
 stiffness matrix
 .97594620E-02 -.29562935E-03 -.75027124E-09  .72025612E-08  .32076552E-08
 .12842036E-08 -.90451014E-10 -.17520828E-09  .61166345E-10 -.19514395E-09
 .20449663E-08 -.59903455E-09  .11734955E-11 -.11566431E-11  .82897331E-12
 .18224390E-11  .91230355E-12  .33761495E-10  .12195177E-10  .39046523E-12
-.23182122E-12 -.45045983E-12 -.50303460E-11 -.16273291E-11 -.29563182E-03
 .97595435E-02  .26340700E-09  .24106267E-09  .33302668E-07  .19099210E-09
 .17684183E-09 -.21551112E-09 -.30152319E-10 -.62306491E-11  .13513914E-08
-.89381996E-08  .28259460E-11 -.90398944E-11  .13342475E-11 -.81528791E-12
-.22587225E-11  .35773535E-11  .13680596E-09  .72885717E-11  .13210152E-12
-.79094623E-12 -.24557427E-12 -.23989233E-10 -.15639020E-08  .54905123E-09
 .20343024E-01 -.26079975E-09  .48565154E-08  .94600863E-09  .98901407E-10
-.64254611E-10 -.19314411E-11 -.11407272E-09  .99913434E-10 -.10561077E-08
-.12958944E-12  .94279651E-12  .10015730E-12 -.57997122E-12  .18743726E-12
```

-.33130988E-12	.15637630E-10	-.59105368E-12	-.93439414E-13	-.27921324E-13
.81773561E-13	-.27093940E-11	.49050780E-07	.16417779E-08	-.85207293E-09
.66464133E-01	.19475411E-03	.70269359E-07	-.16237297E-07	.45511788E-08
.61626102E-10	-.42892336E-08	.10795968E-08	.57553439E-09	.48250404E-10
.10784259E-09	-.75078960E-11	.38099994E-11	-.29288332E-10	-.68250243E-10
-.33409452E-10	-.10524932E-09	.17471826E-10	-.66418785E-11	-.25134243E-10
.18277811E-10	.21845110E-07	.22679724E-06	.15867112E-07	.19475462E-03
.66464305E-01	.47315439E-07	-.35768462E-07	-.10346396E-06	.55332801E-08
-.29915172E-08	-.29780635E-08	.11768222E-08	-.11051827E-09	-.28583534E-09
-.13254065E-10	.13294086E-09	.38057802E-09	-.48296946E-10	.62028220E-10
.12099541E-09	-.92194702E-11	-.85621868E-10	-.16899667E-11	.10770092E-10
.11302504E-07	.16809534E-08	.39943453E-08	.90812287E-07	.61147734E-07
.85894623E-01	-.71430461E-08	.20915017E-08	.96492788E-09	.86143002E-08
-.10576290E-07	.60241884E-08	-.11344353E-09	.24197689E-09	-.10012414E-09
.19655470E-10	-.25911887E-10	-.12651469E-09	-.11260067E-09	.27711122E-10
.10422433E-11	-.47322329E-11	.23975455E-10	.12585346E-10	-.19775410E-08
.38697774E-08	.10379095E-08	-.52157042E-07	-.11489221E-06	-.17754025E-07
.21349168E+00	-.21187502E-01	.47810000E-08	-.85307615E-08	.68817988E-07
-.10708940E-06	.50448730E-10	-.46755022E-10	.30712267E-10	.33803654E-10
.15965556E-10	.69886272E-09	.12220632E-08	.21628280E-10	-.78725297E-11
-.17381897E-10	-.96488084E-10	-.19868499E-09	-.38323239E-08	-.47144921E-08
-.67436058E-09	.14619108E-07	-.33233900E-06	.51984276E-08	-.21187509E-01
.21349175E+00	-.42856447E-08	.35137127E-08	.33059276E-07	-.33370775E-06
.62597345E-10	-.21700140E-09	.25569023E-10	-.43772625E-10	-.89149742E-10
-.12003948E-09	.35860843E-08	.16675823E-09	.65427100E-12	-.12334270E-10
.23731088E-10	-.62821713E-09	.18497242E-08	-.91183816E-09	-.28036982E-10
.27364911E-09	.24570374E-07	.33154821E-08	.66093311E-08	-.59245192E-08
.29513290E+00	.37519809E-08	-.69733084E-08	.44873745E-07	.28192923E-11
-.19683526E-10	-.11199895E-12	.17068733E-10	-.10047449E-10	-.16608589E-10
-.39748348E-09	.16947454E-10	.21308173E-11	.12755192E-11	.12553181E-11
.67910129E-10	-.87066875E-08	-.27779292E-09	-.24417141E-08	-.28100677E-07
-.19598723E-07	.43669505E-07	-.17399277E-07	.71665128E-08	.55356311E-08
.43543590E+00	.14810812E-06	-.84720111E-07	.53455607E-09	-.10077465E-08
.39621050E-09	-.90142789E-10	.11631096E-09	.76132617E-09	.62634874E-09
-.96162869E-10	-.55908969E-11	.16693329E-10	-.13693987E-09	-.80752431E-10
.14274801E-06	.94331868E-07	.33459029E-08	.11065514E-07	-.30525020E-07
-.83883518E-07	.21959873E-06	.10549258E-06	-.16096458E-07	.23172014E-06
.68125418E+00	-.27104561E-01	.11614789E-08	.26490362E-08	-.31716511E-09
.85943274E-09	.90728701E-09	-.29221317E-08	.50490366E-09	-.31241205E-08
.51957049E-09	-.61526398E-09	-.73211418E-09	.41751702E-09	-.41815403E-07
-.62392289E-06	-.35367329E-07	.58996564E-08	.12062234E-07	.47779635E-07
-.34172432E-06	-.10648671E-05	.10358214E-06	-.13254778E-06	-.27104623E-01
.68125575E+00	.42582183E-08	.10332833E-07	.43797025E-09	-.43936896E-08
-.13188862E-07	.99646725E-09	-.27074259E-08	-.41693831E-08	.35204549E-09
.27946747E-08	.26429309E-10	-.19132813E-09	.54370530E-09	.12885390E-08
-.26094123E-10	.32796145E-08	-.75165501E-08	-.59794170E-08	.10704220E-08
.13302950E-08	.43492383E-10	.55578312E-08	.77190818E-08	.28298716E-07
.45273599E+01	.33289908E-09	.17573194E-09	.16686711E-09	.32812234E-09
-.13993111E-08	.35471410E-08	-.36583693E-09	.17545295E-10	-.23583057E-10
.19549301E-09	-.46399077E-09	-.68383088E-09	-.53715190E-08	.26488114E-09
.94548621E-08	-.25067621E-07	.16397539E-07	-.12751511E-08	-.59152219E-08
-.38826234E-09	-.13469743E-07	.22631843E-07	.88273977E-07	.42812130E-09
.58201288E+01	-.90943330E-09	-.36104962E-10	-.15585213E-08	-.61692245E-08
.16972432E-07	-.11689674E-08	.10556426E-09	.15428061E-09	.97207921E-09
-.19932091E-08	.84272535E-09	.12524416E-08	.42753780E-10	-.10640459E-08
-.19639654E-08	-.11067963E-07	.13620121E-08	.11243940E-08	-.22333246E-11
.86371992E-08	-.44220668E-08	.60963545E-08	.36836949E-09	-.14823860E-08
.94919248E+01	.11569532E-08	.14240477E-08	.23390508E-08	.39891144E-08
-.17362158E-08	.53773057E-10	-.69087488E-10	-.16684484E-09	-.30710330E-09
.23825826E-08	-.10705752E-08	-.36680513E-09	.71712112E-09	.25667901E-07
.29338338E-08	.20318696E-08	-.26286568E-08	.74191582E-09	-.26544722E-08
.16176156E-07	-.82690075E-07	.47275881E-09	-.79170095E-10	.15625947E-08
.12821483E+02	-.41877293E-03	-.56342791E-07	-.31992622E-06	.10454387E-08
.43863811E-09	.49179440E-09	.31556405E-09	.59403734E-08	.11999282E-08
-.29567965E-08	.11817227E-09	-.56627605E-08	.73391744E-07	-.38683881E-08
.95862784E-09	-.53555396E-08	-.43655302E-09	.34248007E-08	.17076716E-07
-.24822099E-06	.92912736E-09	-.34332976E-08	.19234540E-08	-.41877339E-03
.12821497E+02	.54236081E-07	-.93850374E-06	-.13387797E-07	-.18793480E-10
.94000040E-09	-.13067391E-08	.19214341E-07	.47846913E-07	.51256077E-08
-.22527256E-09	-.14182629E-07	-.10032981E-07	-.20366924E-07	.45262964E-07
-.77773881E-08	-.77815894E-09	.24176875E-07	-.59312892E-07	.20227043E-07

```
-.42740708E-08 -.14657279E-07  .34081278E-08 -.60764954E-07  .58492524E-07
 .13827771E+02  .21047759E-02 -.11938795E-06  .63495967E-08 -.28372832E-08
-.12322523E-07  .35987854E-08  .17313572E-07  .19380609E-06  .10627946E-07
-.69339030E-08  .12880785E-07 -.18128101E-07  .79148965E-07  .23226738E-06
-.18623154E-07  .19890436E-07  .10247543E-07 -.54955412E-07  .10833735E-07
 .40324285E-07  .58103208E-08 -.34503589E-06 -.10121617E-05  .21047783E-02
 .13827787E+02  .13394160E-06 -.30532164E-08 -.29475699E-07 -.23147128E-08
 .69566688E-08  .85737493E-09  .11972471E-07 -.52009481E-09 -.26582230E-07
 .30475180E-07  .54095867E-08  .16790539E-08  .13098546E-07  .95948868E-09
-.36975908E-08 -.76756243E-07 -.10244206E-06 -.13514731E-08 -.33636087E-08
-.30612494E-08  .13646379E-08 -.17478437E-07 -.14452064E-06  .16213823E-06
 .16738775E+02 -.13945359E-08 -.16103805E-08 -.12679180E-07  .10869214E-07
-.91550650E-09 -.33334156E-10 -.16050637E-09  .87776220E-08 -.46153852E-08
 .41203041E-09 -.12472661E-08  .11467520E-09  .24680008E-09 -.43801066E-09
 .25970692E-07  .17595245E-07  .13230540E-09  .61985082E-09  .19168201E-09
 .11644931E-08 -.49596044E-10  .15629549E-07 -.75152029E-08 -.28347009E-08
 .34035455E+02  .20067129E-03  .49914084E-06 -.29113677E-06 -.15969909E-08
-.27153113E-08 -.47502223E-10 -.33529005E-08 -.43896635E-07 -.18777036E-08
-.27762546E-08 -.19675833E-08  .14724131E-09  .13048872E-08 -.30742521E-07
 .13961746E-06 -.17783387E-09  .90098960E-09 -.24823965E-09  .13055799E-08
 .24952241E-08 -.69844069E-08 -.72550516E-07 -.32742397E-08  .20067151E-03
 .34035491E+02 -.20345508E-06 -.25713854E-05 -.17642842E-07 -.97773383E-09
 .14035968E-09 -.12931820E-07 -.88486304E-09  .95699556E-08 -.15492845E-07
 .38072643E-08  .14565520E-09 -.10781761E-07 -.36845727E-07  .13291458E-08
 .14814849E-08  .57271389E-08 -.60505547E-09  .84480496E-09 -.34929367E-08
-.30551212E-07 -.57376276E-08 -.25966143E-07  .50277715E-06 -.20493817E-06
 .34283278E+02 -.40681539E-02 -.57248771E-08 -.84432571E-07 -.45627666E-08
 .94143010E-08  .55387795E-08  .50248116E-08 -.31901744E-07 -.10086897E-06
 .78883295E-08 -.63574471E-08  .21010657E-07 -.96293667E-08 -.35136868E-08
-.11741684E-07 -.11054520E-08  .15883512E-07  .51376341E-07  .89214834E-08
 .17247322E-07  .22259068E-07 -.29325792E-06 -.25901072E-05 -.40681582E-02
 .34283314E+02
         *** zeroth order terms ***

 alpha
-.42285318E-07  .22032523E-08  .19103434E-08 -.46164709E-09 -.25254923E-07
 .15319234E-08 -.92689514E-10 -.41002187E-09 -.56423913E-10  .53935514E-09
 .39637933E-10 -.80781973E-09  .34687579E-10 -.27100970E-09  .57689693E-10
-.98124081E-10  .42222814E-08  .46766094E-10 -.23190343E-08 -.21012612E-09
 .84068331E-10  .67994729E-09 -.13698436E-08  .62753410E-10  .11096251E-10
 .39006386E-10  .73868759E-11  .27987870E-11 -.62247277E-09 -.59775470E-11
 .17590884E-09  .76219460E-11 -.26366890E-09  .11876573E-10  .28290161E-10
-.27201298E-10  .89869863E-12 -.15751250E-11 -.33157375E-12  .70866876E-12
-.24551181E-11 -.42785452E-10  .34373229E-12  .11944186E-12 -.30843212E-12
 .15203202E-10  .15923719E-12 -.27557073E-12 -.68722572E-12  .78199706E-11
-.53600279E-12  .35222275E-11 -.10833770E-12 -.38667210E-11  .24012255E-12
-.22349588E-13  .72325799E-13 -.72369183E-12  .14903493E-11  .24910814E-10
 .17123480E-11  .30860344E-13  .45896282E-13  .35510380E-13 -.12439625E-11
 .66833265E-13 -.45804903E-12 -.82105459E-14  .84237205E-12  .62945655E-13
-.81003566E-13  .43653901E-13
 h matrix
-.41919760E+00  .56538237E+00 -.43485534E-01 -.48726399E+01 -.14092839E+00
 .31621688E+00 -.15658688E+00 -.17361672E-01 -.21636943E-02 -.21186125E-01
 .26295445E+00  .10634541E-02  .39837270E+00  .24038060E-01  .34138213E-02
 .72810429E-01 -.66125938E-01 -.14508666E-01 -.87470672E-01  .13982584E-01
 .20325687E-02 -.26138318E+00 -.13271355E-01  .17000778E-01  .16625637E-01
-.30466702E-03  .92471384E-04 -.13678233E-01  .14351589E-01  .35179758E-02
 .18275688E-02  .81441214E-01  .37327408E-03 -.11565896E+00 -.94944608E-03
-.86128442E-03 -.44776941E-03 -.16313018E-03 -.15718717E-04 -.10522228E-02
 .90631992E-05  .49761828E-04 -.64926039E-04  .27152761E-04 -.19410130E-04
 .46028011E-03  .13453022E-03  .19224888E-06  .13666807E-02  .14309527E-03
-.11088438E-03 -.18934576E-03  .15159582E-02  .53961923E-05  .20500426E-02
 .20016096E-03  .90999899E-05  .44426853E-03  .45524403E-04  .33906200E-05
-.32663380E-04 -.43305067E-04 -.94350657E-07 -.31076189E-03  .13804808E-04
 .12272265E-04 -.36541686E-04 -.23880534E-03 -.33501440E-06 -.17757456E-03
-.13655382E-03 -.30751912E-05
 s1
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
```

```
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00
  *** first order terms ***

 i_1  m_i^b
 .89381792E-01  .00000000E+00  .00000000E+00  .00000000E+00  .89381792E-01
 .00000000E+00 -.58177179E+00 -.43307251E+00  .00000000E+00 -.10178988E+01
 .00000000E+00  .00000000E+00  .00000000E+00 -.10178988E+01  .00000000E+00
 .15376649E+00 -.50245233E+01  .00000000E+00  .71852291E-02  .00000000E+00
 .00000000E+00  .00000000E+00  .71852291E-02  .00000000E+00  .28424090E-01
-.17291849E+00  .00000000E+00 -.10551282E-01  .00000000E+00  .00000000E+00
 .00000000E+00 -.10551282E-01  .00000000E+00 -.40492477E+05 -.23515802E+04
 .00000000E+00 -.31408004E-01  .00000000E+00  .00000000E+00  .00000000E+00
-.31408004E-01  .00000000E+00  .22328507E+04 -.40498476E+05  .00000000E+00
 .33870978E+05  .00000000E+00  .00000000E+00  .00000000E+00  .33870978E+05
 .00000000E+00  .24388227E-01  .23658852E-01  .00000000E+00  .31851587E-01
 .00000000E+00  .00000000E+00  .00000000E+00  .31851587E-01  .00000000E+00
-.16187775E-01 -.96444085E-01  .00000000E+00 -.53418857E-01  .00000000E+00
 .00000000E+00  .00000000E+00 -.53418857E-01  .00000000E+00  .12105322E-01
-.28935991E+00  .00000000E+00 -.11132880E-03  .00000000E+00  .00000000E+00
 .00000000E+00 -.11132880E-03  .00000000E+00 -.11476862E-02  .30969398E-01
 .00000000E+00 -.22321987E+05  .00000000E+00  .00000000E+00  .00000000E+00
-.22321987E+05  .00000000E+00 -.31998031E-01 -.29477051E-01  .00000000E+00
 .11286377E-02  .00000000E+00  .00000000E+00  .00000000E+00  .11286377E-02
 .00000000E+00 -.59876589E+05 -.98431220E+04  .00000000E+00 -.35882781E-02
 .00000000E+00  .00000000E+00  .00000000E+00 -.35882781E-02  .00000000E+00
-.74530641E+04  .60220631E+05  .00000000E+00  .34407691E+06  .00000000E+00
 .00000000E+00  .00000000E+00  .34407691E+06  .00000000E+00 -.20702927E-04
 .84613530E-04  .00000000E+00 -.20271109E-05  .00000000E+00  .00000000E+00
 .00000000E+00 -.20271109E-05  .00000000E+00  .60214464E-02  .31309394E-02
 .00000000E+00  .21803208E+06  .00000000E+00  .00000000E+00  .00000000E+00
 .21803208E+06  .00000000E+00  .35046731E-06  .20448791E-05  .00000000E+00
 .13462938E+00  .00000000E+00  .00000000E+00  .00000000E+00  .13462938E+00
```

```
 .00000000E+00  .25977374E-05  .10399210E-03  .00000000E+00 -.81973301E-01
 .00000000E+00  .00000000E+00  .00000000E+00 -.81973301E-01  .00000000E+00
-.15155120E-04  .18537988E-03  .00000000E+00 -.55950132E-05  .00000000E+00
 .00000000E+00  .00000000E+00 -.55950132E-05  .00000000E+00 -.50422495E+04
-.40884484E+02  .00000000E+00 -.70074319E-03  .00000000E+00  .00000000E+00
 .00000000E+00 -.70074319E-03  .00000000E+00  .40113806E+02 -.50422499E+04
 .00000000E+00 -.10789343E-03  .00000000E+00  .00000000E+00  .00000000E+00
-.10789343E-03  .00000000E+00 -.15519734E-03  .54725953E-02  .00000000E+00
-.15473569E-01  .00000000E+00  .00000000E+00  .00000000E+00 -.15473569E-01
 .00000000E+00 -.44691498E-04  .61545868E-04  .00000000E+00 -.16490171E-01
 .00000000E+00  .00000000E+00  .00000000E+00 -.16490171E-01  .00000000E+00
 .70316673E-04  .10593837E-03  .00000000E+00 -.22504118E-05  .00000000E+00
 .00000000E+00  .00000000E+00 -.22504118E-05  .00000000E+00 -.30912152E+04
 .15565069E+04  .00000000E+00  .66447651E-04  .00000000E+00  .00000000E+00
 .00000000E+00  .66447651E-04  .00000000E+00 -.15561377E+04 -.30913985E+04
 .00000000E+00
gamma_2  y_ki^b
-.62607851E-07 -.50794938E-06  .17478712E-01  .51856264E-06 -.78861303E-08
-.10052474E+01 -.73381075E-03 -.13366523E-01  .45386799E-06  .36717330E-07
 .34244087E-06  .21280028E-06 -.34124540E-06  .38838113E-07 -.21262985E-06
-.33159527E-07  .43796371E-07 -.24642116E-05  .13404742E-06 -.82364180E-06
 .18701826E-02  .80726494E-06  .22112481E-06  .17620561E-01 -.53324649E-02
-.28274991E-01 -.60964083E-07  .18974310E-07 -.16027134E-07  .26374269E-06
 .21157972E-08 -.24413690E-06 -.10930903E-06 -.24235997E-06  .10887613E-07
-.13773702E-06 -.74355275E-06  .86344820E-06 -.86348556E-08 -.10594211E+00
-.72922176E-01  .12741219E-07 -.80583169E-06  .12968028E-05 -.14501437E-06
-.91143541E-07  .15942143E-06 -.12557840E+00 -.16085783E-06 -.84422487E-07
 .47379413E+00 -.16763984E-06 -.73009900E-06  .48745525E-06 -.27553639E-06
-.28304144E-05 -.20161874E-06 -.21301848E+00 -.18980035E+01 -.16449225E-07
-.15146456E-06 -.22667613E-06 -.27864015E+00 -.22686122E-06  .15001301E-06
-.75692354E+00  .85227134E-07  .54382657E-06 -.11012196E-05  .35436475E-07
 .14708492E-05  .62332048E-06 -.51856264E-06  .78861303E-08  .10052474E+01
 .38444042E-06 -.36081121E-07  .17478850E-01  .13382617E-01 -.32858247E-03
-.72393559E-07 -.19119526E-07 -.39108756E-06  .34672207E-05  .38988118E-06
-.19214899E-07 -.15281638E-07 -.38279177E-06 -.12413706E-07 -.11021283E-06
 .99446352E-07 -.60651059E-06 -.17943828E-01  .58761898E-06  .15995717E-06
 .31010888E-02  .28423613E-01 -.44735140E-02  .26039509E-08  .16609008E-06
 .45472414E-07  .37293498E-07 -.10498110E-06  .45860445E-06 -.93834662E-06
 .45908021E-06  .88219631E-07  .18403367E-06 -.78571358E-05 -.80752560E-06
-.22489195E-06  .76105503E-01 -.10368437E+00  .15769748E-08 -.10568617E-04
 .57565891E-06  .76217949E-06 -.74044170E-07  .11391547E-06 -.46976639E+00
-.12058674E-06 -.75683469E-07 -.13985513E+00  .10506104E-05  .54053200E-06
 .30253741E-05  .21515236E-05  .12619873E-06  .20116967E-05  .19035792E+01
-.15542683E+00 -.27743136E-08 -.12645160E-06 -.20146267E-06 -.74812742E+00
-.20000508E-06  .12631014E-06  .30143385E+00 -.10593951E-05 -.15030137E-05
-.77536846E-05  .10054546E-06 -.52218327E-06 -.39275247E-05  .73381075E-03
 .13366523E-01 -.45386799E-06 -.13382617E-01  .32858247E-03  .72393559E-07
 .54588498E-07 -.11666072E-07  .14310395E-13 -.71385118E-09  .88880863E-08
 .18767167E-06  .19211684E-08  .68511270E-09  .23711830E-07  .25343822E-07
-.10409501E-07  .56561332E-12 -.21846001E-01  .12358662E+00  .57679267E-07
-.12080850E+00 -.34003255E-01 -.19362683E-07 -.45282224E-07  .61839009E-08
 .75797873E-14  .13743203E-06  .22855908E-08 -.88236331E-13 -.28600792E-09
 .22856711E-07 -.87464909E-07 -.79568074E-08  .51110757E-09  .14175266E-07
-.23010227E-06 -.98727685E-07  .43416653E-13 -.24898360E-06  .91483883E-07
-.77664092E-13 -.45284969E-06  .42741722E-07 -.21249170E-12 -.13278546E-01
-.52285061E-01  .14719014E-06  .52285564E-01 -.13276810E-01 -.63399074E-08
-.26217801E-08 -.39483112E-08  .92799969E-07  .35017562E-08 -.20853839E-08
 .83171247E-07 -.65246642E-06  .17160470E-06 -.41382889E-12 -.23320671E-01
-.71358750E-01  .15696020E-06 -.71358882E-01  .23320214E-01 -.38814806E-07
 .47261019E-08  .11104159E-07 -.25209767E-06 -.82271192E-08  .34017979E-08
-.17927404E-06 -.36717330E-07 -.34244087E-06 -.21280028E-06  .19119526E-07
 .39108756E-06 -.34672207E-05  .71385118E-09 -.88880863E-08 -.18767167E-06
 .77264000E-09  .56089073E-08  .25542566E-01 -.54712968E-08  .45510576E-09
-.83092402E+00 -.28447933E-03  .22671016E-02 -.12113218E-05 -.56448434E-07
 .24611815E-06  .73965692E-06 -.24294989E-06 -.44164116E-07  .23229657E-05
-.35178955E-09 -.14722675E-07 -.16092113E-06  .65717217E-02  .49474668E-01
 .21395490E-06 -.14410719E-08 -.40903978E-08  .60441216E-01 -.11126326E-08
 .49737407E-08 -.53923648E+00 -.94714179E-01 -.64899273E+00 -.34678836E-08
-.10559694E-07 -.39960159E-06  .37782460E-06  .13940018E+00  .12146079E+01
-.12958433E-08  .19372121E-06  .13219075E-05  .14943658E-08  .80698553E-07
-.19053734E-06  .77887080E-07  .39680923E-08  .64423900E-08  .19692464E-01
```

-.67860925E-08	.11108030E-08	-.36522737E-04	-.71710619E-08	-.46661594E-06
.20025118E-06	.65869035E-07	.31119132E-06	-.19170180E-07	-.48891040E-08
-.41439984E-06	-.18152134E-07	-.76837879E-08	-.16366625E-07	-.11419001E+00
.16399263E-07	-.73058140E-08	.94493068E-01	.34124540E-06	-.38838113E-07
.21262985E-06	-.38988118E-06	.19214899E-07	.15281638E-07	-.19211684E-08
-.68511270E-09	-.23711830E-07	.54712968E-08	-.45510576E-09	.83092402E+00
-.17031265E-07	.24014354E-08	.25542495E-01	-.22678700E-02	-.27782968E-03
.11184452E-05	.62194659E-07	-.47712538E-06	-.76244129E-07	.43215597E-06
.10569704E-06	.33350487E-07	-.71735340E-08	-.38147924E-09	.10918412E-07
-.49455263E-01	.67166526E-02	-.25146107E-06	-.93566548E-09	-.57381558E-08
-.53707875E+00	-.90587906E-08	.40903232E-08	-.40597617E-01	.64871410E+00
-.96615212E-01	-.60262836E-09	-.18891624E-06	-.98396479E-08	.89202189E-07
-.12141936E+01	.14295856E+00	.23050185E-09	-.14209128E-05	.23416354E-06
.35761913E-07	.15420580E-06	-.19440207E-07	.14128991E-08	.11873660E-07
.19292084E-07	.96879863E-04	-.16434235E-07	.11524456E-07	.19691541E-01
-.22074571E-06	-.15404011E-07	-.27221783E-06	-.28954207E-06	.78314182E-07
.29898828E-08	.42591726E-06	-.27558297E-07	-.32855064E-08	-.22910605E-07
-.48721700E-07	-.94812449E-01	.48349038E-07	-.22872252E-07	-.11390138E+00
.33159527E-07	-.43796371E-07	.24642116E-05	.38279177E-06	.12413706E-07
.11021283E-06	-.25343822E-07	.10409501E-07	-.56561332E-12	.28447933E-03
-.22671016E-02	.12113218E-05	.22678700E-02	.27782968E-03	-.11184452E-05
-.38364585E-09	-.37498631E-08	.35516869E-12	-.22295994E-07	-.84358887E-08
-.17454190E-05	-.61060311E-07	.22204943E-07	.56177629E-06	.13463461E-06
-.14755869E-07	-.18433634E-12	-.72183338E-07	.90190096E-07	-.75307473E-13
.36174635E-02	.19730933E-01	-.68628116E-06	.19571357E-01	-.43996180E-02
-.78227017E-06	.96672133E-06	-.11372652E-05	-.81782833E-13	.37524982E-05
-.34633772E-06	.73163584E-12	-.14240023E-05	.16913358E-05	.85314857E-12
-.30146541E-08	.35978002E-08	-.45661113E-06	-.42909184E-08	-.19153162E-08
.50616539E-07	-.12756037E-01	-.20183313E-01	-.54931006E-07	.20181394E-01
-.12759081E-01	.42808564E-07	.36247494E-05	-.29293728E-06	-.11631316E-12
-.31447785E-08	-.59196241E-08	.10223336E-07	-.49032229E-08	.29885627E-08
.83085912E-07	.26910936E-01	.53138454E-01	-.10396571E-06	-.53141657E-01
.26904645E-01	-.94708623E-07	-.13404742E-06	.82364180E-06	-.18701826E-02
-.99446352E-07	.60651059E-06	.17943828E-01	.21846001E-01	-.12358662E+00
-.57679267E-07	.56448434E-07	-.24611815E-06	-.73965692E-06	-.62194659E-07
.47712538E-06	.76244129E-07	.22295994E-07	.84358887E-08	.17454190E-05
.47263847E-08	-.24842569E-07	-.74612173E-02	.33702520E-07	.52587698E-08
-.99165381E+00	-.24130997E-02	.27251892E-01	-.20230691E-06	.42383207E-07
-.11484143E-07	.90215619E-06	-.40538688E-08	.59415338E-07	.40772390E-06
-.88506639E-09	-.26291127E-07	.93122118E-07	-.70112029E-06	.18615170E-06
-.27093746E-06	-.11513953E+00	.10016519E+01	.10444111E-07	.66967927E-06
-.22081894E-06	.29618344E-06	-.36225913E-08	.85213715E-08	-.40353386E-01
-.80313089E-08	-.50214583E-08	.13026438E+00	-.79053746E-07	.70869914E-06
.84282940E-07	.96353235E-10	.81235041E-06	.18225686E-07	.92446699E-02
.36511561E+00	-.12675867E-07	-.57668967E-08	-.84437859E-08	-.19320351E-01
-.83112891E-08	.55592945E-08	-.12118342E+00	.37021885E-07	-.17801169E-06
-.12499195E-06	-.55451004E-07	-.26193636E-06	.18332552E-07	-.80726494E-06
-.22112481E-06	-.17620561E-01	-.58761898E-06	-.15995717E-06	-.31010888E-02
.12080850E+00	.34003255E-01	.19362683E-07	.24294989E-06	.44164116E-07
-.23229657E-05	-.43215597E-06	-.10569704E-06	-.33350487E-07	.61060311E-07
-.22204943E-07	-.56177629E-06	-.33702520E-07	-.52587698E-08	.99165381E+00
.19757764E-07	.81710904E-08	-.74615305E-02	-.26877854E-01	-.51057423E-02
.67961445E-07	.12974058E-06	-.90406751E-08	-.26684890E-06	-.65884970E-07
.26442837E-06	.13464373E-05	.30067542E-06	-.20275997E-08	.86886469E-07
-.21444915E-05	.11187428E-06	-.77099669E-07	-.98527966E+00	-.21397787E+00
-.14263427E-08	.20740004E-05	-.23288741E-06	.46545419E-07	.87483772E-09
.17211154E-07	-.12561504E+00	-.15869406E-07	.14981146E-08	-.53077809E-01
-.69826092E-06	-.93248306E-07	.23220378E-06	-.86409724E-06	-.81421980E-07
.11449558E-06	-.36422996E+00	-.27036148E-01	.14001264E-08	.48725385E-08
.12206505E-07	-.11866768E+00	.12399628E-07	-.47190946E-08	.31250391E-01
.23088390E-06	-.32957092E-07	-.37125093E-06	.35360159E-06	.28254188E-07
-.38520272E-07	.53324649E-02	.28274991E-01	.60964083E-07	-.28423613E-01
.44735140E-02	-.26039509E-08	.45282224E-07	-.61839009E-08	-.75797873E-14
.35178955E-09	.14722675E-07	.16092113E-06	.71735340E-08	.38147924E-09
-.10918412E-07	-.13463461E-06	.14755869E-07	.18433634E-12	.24130997E-02
-.27251892E-01	.20230691E-06	.26877854E-01	.51057423E-02	-.67961445E-07
-.19610946E-09	-.12793244E-08	-.40284160E-14	-.83006278E-07	.16727198E-07
-.31503409E-13	-.12027390E-08	-.79489702E-08	-.94373911E-07	-.70395759E-09
-.24600259E-09	-.61037343E-08	.20879089E-06	-.14299961E-07	-.29220077E-13
-.15107758E-06	.17930787E-07	.35600382E-13	-.18459429E-06	.73257490E-07
.32197615E-13	-.11934809E-01	-.24773363E-01	-.28562365E-07	.24773764E-01

-.11933949E-01	.10299928E-08	.93398544E-10	.13727412E-09	-.23093011E-07
-.54977989E-09	.38611032E-09	-.12072820E-07	-.34175860E-07	.90726267E-08
.25781137E-13	-.30017386E-01	-.48004147E-01	-.21394263E-07	-.48004340E-01
.30017176E-01	-.16597444E-08	.15204283E-09	-.22344016E-10	.41855726E-07
.19779770E-08	-.13203123E-08	.89135235E-08	-.18974310E-07	.16027134E-07
-.26374269E-06	-.16609008E-06	-.45472414E-07	-.37293498E-07	-.13743203E-06
-.22855908E-08	.88236331E-13	-.65717217E-02	-.49474668E-01	-.21395490E-06
.49455263E-01	-.67166526E-02	.25146107E-06	.72183338E-07	-.90190096E-07
.75307473E-13	-.42383207E-07	.11484143E-07	-.90215619E-06	-.12974058E-06
.90406751E-08	.26684890E-06	.83006278E-07	-.16727198E-07	.31503409E-13
.10960857E-07	-.12663272E-07	-.12636246E-13	-.19959259E-02	.72617544E-01
.79350189E-07	.72639356E-01	-.89484432E-03	.11343359E-06	-.16459085E-06
.21258826E-06	.17755656E-12	.50741177E-06	-.65700277E-07	-.13810761E-12
.12668197E-06	-.19034335E-06	-.24898461E-12	.48485096E-09	-.38632258E-09
.20325780E-06	.53522249E-09	.18948680E-10	.27623676E-08	.84150598E-02
.17168433E-01	.34115338E-07	-.17167179E-01	.84177208E-02	-.13940941E-07
-.51059035E-07	-.57298172E-07	.20698406E-13	.94233533E-10	.50069943E-09
.11013082E-06	.50976879E-11	-.19275352E-09	.15874235E-08	-.41887505E-02
-.31354146E-01	-.46431865E-07	.31354628E-01	-.41849538E-02	.36824273E-07
-.21157972E-08	.24413690E-06	.10930903E-06	.10498110E-06	-.45860445E-06
.93834662E-06	.28600792E-09	-.22856711E-07	.87464909E-07	.14410719E-08
.40903978E-08	-.60441216E-01	.93566548E-09	.57381558E-08	.53707875E+00
-.36174635E-02	-.19730933E-01	.68628116E-06	.40538688E-08	-.59415338E-07
-.40772390E-06	.65884970E-07	-.26442837E-06	-.13464373E-05	.12027390E-08
.79489702E-08	.94373911E-07	.19959259E-02	-.72617544E-01	-.79350189E-07
-.70696657E-10	.59061577E-09	.15406909E-02	-.20017513E-08	-.22674296E-08
.18271839E+00	-.29420640E-01	.35553316E+00	.10890627E-08	-.22036796E-08
.72972846E-07	-.18535266E-06	.15383984E-02	-.28931664E+00	.30106500E-09
.35186887E-07	-.34894224E-06	-.12497649E-08	-.41746864E-07	.22875467E-07
.45437189E-07	-.42673819E-09	-.78136072E-09	.29073755E-01	.83848781E-09
-.30068531E-10	-.41762028E-01	.54019335E-08	-.52857311E-07	.69439023E-07
.39767875E-07	.76296204E-08	-.21121434E-08	.11553120E-06	.45920329E-07
-.21718772E-07	.44647683E-09	.16416114E-08	-.28098883E-01	-.16609482E-08
.44578552E-09	.79066663E-01	.24235997E-06	-.10887613E-07	.13773702E-06
-.45908021E-06	-.88219631E-07	-.18403367E-06	.79568074E-08	-.51110757E-09
-.14175266E-07	.11126326E-08	-.49737407E-08	.53923648E+00	.90587906E-08
-.40903232E-08	.40597617E-01	-.19571357E-01	.43996180E-02	.78227017E-06
.88506639E-09	.26291127E-07	-.93122118E-07	-.30067542E-06	.20275997E-08
-.86886469E-07	.70395759E-09	.24600259E-09	.61037343E-08	-.72639356E-01
.89484432E-03	-.11343359E-06	.20017513E-08	.22674296E-08	-.18271839E+00
-.15690317E-08	.10989807E-09	.15406299E-02	.35642111E+00	.15252056E-01
-.15551538E-09	.11525644E-08	.22841308E-08	.53271028E-07	-.28914783E+00
.99735803E-02	-.80529120E-11	-.39209234E-06	.26942708E-07	-.40357060E-08
-.23699116E-07	-.12256696E-08	.39578955E-08	.13718954E-08	.23672818E-08
-.42889921E-01	-.19728023E-08	.12993543E-08	-.27395597E-01	.10482756E-07
-.36015513E-08	.59618938E-07	-.98494637E-07	.30215091E-07	.83151351E-09
.11154142E-06	-.12729912E-07	-.22012824E-08	-.20575968E-08	-.54136933E-08
.80118470E-01	.54141545E-08	-.20376560E-08	.24921274E-01	.74355275E-06
-.86344820E-06	.86348556E-08	.78571358E-05	.80752560E-06	.22489195E-06
.23010227E-06	.98727685E-07	-.43416653E-13	.94714179E-01	.64899273E+00
.34678836E-08	-.64871410E+00	.96615212E-01	.60262836E-09	-.96672133E-06
.11372652E-05	.81782833E-13	.70112029E-06	-.18615170E-06	.27093746E-06
.21444915E-05	-.11187428E-06	.77099669E-07	-.20879089E-06	.14299961E-07
.29220077E-13	.16459085E-06	-.21258826E-06	-.17755656E-12	.29420640E-01
-.35553316E+00	-.10890627E-08	-.35642111E+00	-.15252056E-01	.15551538E-09
.19702911E-08	.17067919E-09	-.67397229E-14	.43502667E-06	.23008021E-06
-.18534110E-15	-.31921334E-09	-.49233010E-09	-.98795752E-14	-.46272789E-08
.32747580E-08	.41693501E-08	-.86543027E-08	.51209400E-08	-.21513879E-08
-.12962772E+00	-.22610792E+00	-.55780767E-10	.22608848E+00	-.12966222E+00
-.46893542E-10	-.63686977E-06	.54634427E-06	.37138548E-15	.86753266E-08
.74221774E-08	.46945470E-08	.16797908E-07	-.91574736E-08	.19556552E-08
.19954144E+00	.51982556E+00	.11311457E-09	-.51984922E+00	.19947944E+00
.51066096E-10	.10594211E+00	.72922176E-01	-.12741219E-07	-.76105503E-01
.10368437E+00	-.15769748E-08	.24898360E-06	-.91483883E-07	.77664092E-13
.10559694E-07	.39960159E-06	-.37782460E-06	.18891624E-06	.98396479E-08
-.89202189E-07	-.37524982E-05	.34633772E-06	-.73163584E-12	.11513953E+00
-.10016519E+01	-.10444111E-07	.98527966E+00	.21397787E+00	.14263427E-08
.15107758E-06	-.17930787E-07	-.35600382E-13	-.50741177E-06	.65700277E-07
.13810761E-12	.22036796E-08	-.72972846E-07	.18535266E-06	-.11525644E-08
-.22841308E-08	-.53271028E-07	-.43502667E-06	-.23008021E-06	.18534110E-15
-.12392972E-07	-.12119306E-08	-.18085362E-13	-.25448515E-06	-.24080342E-06

-.72100480E-15	.42365812E-01	.22743214E+00	.53395066E-09	-.22743389E+00
.42358362E-01	.13756098E-09	-.34009417E-09	-.36617465E-08	-.44502412E-08
.50488788E-08	-.25689226E-08	.32032115E-08	.14881036E-07	.20788290E-08
-.53416876E-14	.49700530E-01	.27168256E+00	.17278504E-09	.27168278E+00
-.49698521E-01	-.46204715E-10	-.72402280E-09	-.51155317E-09	.66103844E-08
-.10387562E-07	.27226537E-08	-.73095770E-08	.80583169E-06	-.12968028E-05
.14501437E-06	.10568617E-04	-.57565891E-06	-.76217949E-06	.45284969E-06
-.42741722E-07	.21249170E-12	-.13940018E+00	-.12146079E+01	.12958433E-08
.12141936E+01	-.14295856E+00	-.23050185E-09	.14240023E-05	-.16913358E-05
-.85314857E-12	-.66967927E-06	.22081894E-06	-.29618344E-06	-.20740004E-05
.23288741E-06	-.46545419E-07	.18459429E-06	-.73257490E-07	-.32197615E-13
-.12668197E-06	.19034335E-06	.24898461E-12	-.15383984E-02	.28931664E+00
-.30106500E-09	.28914783E+00	-.99735803E-02	.80529120E-11	.31921334E-09
.49233010E-09	.98795752E-14	.25448515E-06	.24080342E-06	.72100480E-15
.80857846E-09	-.65913199E-09	-.89837874E-14	-.40276693E-08	.23299565E-08
.33531355E-09	-.74204357E-08	.35521019E-08	.62833350E-08	-.82095560E-01
-.12224359E+00	-.26190706E-11	.12223122E+00	-.82113856E-01	-.75550354E-12
-.49434274E-06	.52138355E-06	-.36084625E-15	.72258733E-08	.45094717E-08
.82984545E-09	.11398262E-07	-.86245755E-08	-.84823258E-08	.20012965E+00
.34933873E+00	.29523672E-11	-.34936258E+00	.20008846E+00	-.35514320E-11
.91143541E-07	-.15942143E-06	.12557840E+00	.74044170E-07	-.11391547E-06
.46976639E+00	.13278546E-01	.52285061E-01	-.14719014E-06	-.19372121E-06
-.13219075E-05	-.14943658E-08	.14209128E-05	-.23416354E-06	-.35761913E-07
.30146541E-08	-.35978002E-08	.45661113E-06	.36225913E-08	-.85213715E-08
.40353386E-01	-.87483772E-09	-.17211154E-07	.12561504E+00	.11934809E-01
.24773363E-01	.28562365E-07	-.48485096E-09	.38632258E-09	-.20325780E-06
-.35186887E-07	.34894224E-06	.12497649E-08	.39209234E-06	-.26942708E-07
.40357060E-08	.46272789E-08	-.32747580E-08	-.41693501E-08	-.42365812E-01
-.22743214E+00	-.53395066E-09	.40276693E-08	-.23299565E-08	-.33531355E-09
-.13190608E-09	-.42992791E-09	.53549523E-03	.44221408E-09	-.15144278E-09
-.50250104E-02	-.53621168E-07	-.78323735E-07	-.76419772E-10	.67488837E-07
-.40301963E-07	.71900559E-10	-.38245326E-02	.95707833E-02	.28472227E-09
-.26263013E-09	-.59806850E-09	.30586106E-02	-.60005167E-09	.27669342E-09
.65749091E-02	.13037445E-06	.21701737E-06	.12705909E-09	-.21430064E-06
.12189418E-06	-.18933107E-09	.16085783E-06	.84422487E-07	-.47379413E+00
.12058674E-06	.75683469E-07	.13985513E+00	-.52285564E-01	.13276810E-01
.63399074E-08	-.80698553E-07	.19053734E-06	-.77887080E-07	-.15420580E-06
.19440207E-07	-.14128991E-08	.42909184E-08	.19153162E-08	-.50616539E-07
.80313089E-08	.50214583E-08	-.13026438E+00	.15869406E-07	-.14981146E-08
.53077809E-01	-.24773764E-01	.11933949E-01	-.10299928E-08	-.53522249E-09
-.18948680E-10	-.27623676E-08	.41746864E-07	-.22875467E-07	-.45437189E-07
.23699116E-07	.12256696E-08	-.39578955E-08	.86543027E-08	-.51209400E-08
.21513879E-08	.22743389E+00	-.42358362E-01	-.13756098E-09	.74204357E-08
-.35521019E-08	-.62833350E-08	-.44221408E-09	.15144278E-09	.50250104E-02
-.10011899E-08	.39672401E-09	.53548366E-03	.35302623E-07	.45619868E-07
-.18324191E-09	-.58945067E-07	.24482274E-07	-.14363279E-09	-.95706411E-02
-.38248253E-02	.52950837E-10	.80178997E-09	.17350601E-08	.65747891E-02
.17209949E-08	-.80376640E-09	-.30587738E-02	-.65962710E-07	-.12765379E-06
.24445245E-09	.13611625E-06	-.63215067E-07	.27202374E-09	.16763984E-06
.73009900E-06	-.48745525E-06	-.10506104E-05	-.54053200E-06	-.30253741E-05
.26217801E-08	.39483112E-08	-.92799969E-07	-.39680923E-08	-.64423900E-08
-.19692464E-01	-.11873660E-07	-.19292084E-07	-.96879863E-04	.12756037E-01
.20183313E-01	.54931006E-07	.79053746E-07	-.70869914E-06	-.84282940E-07
.69826092E-06	.93248306E-07	-.23220378E-06	-.93398544E-10	-.13727412E-09
.23093011E-07	-.84150598E-02	-.17168433E-01	-.34115338E-07	.42673819E-09
.78136072E-09	-.29073755E-01	-.13718954E-08	-.23672818E-08	.42889921E-01
.12962772E+00	.22610792E+00	.55780767E-10	.34009417E-09	.36617465E-08
.44502412E-08	.82095560E-01	.12224359E+00	.26190706E-11	.53621168E-07
.78323735E-07	.76419772E-10	-.35302623E-07	-.45619868E-07	.18324191E-09
.16412533E-11	.21384164E-11	.32021163E-03	.58936241E-11	-.14505988E-10
-.33385669E-02	-.42306378E-10	-.13863650E-08	.83012671E-08	-.56730240E-07
-.96467007E-07	-.10535633E-09	-.91711930E-07	.55460535E-07	-.51525169E-09
-.43381873E-11	-.92974491E-11	-.29258756E-02	.76083731E-11	.16981023E-11
.72526267E-02	.27553639E-06	.28304144E-05	.20161874E-06	-.21515236E-05
-.12619873E-06	-.20116967E-05	-.35017562E-08	.20853839E-08	-.83171247E-07
.67860925E-08	-.11108030E-08	.36522737E-04	.16434235E-07	-.11524456E-07
-.19691541E-01	-.20181394E-01	.12759081E-01	-.42808564E-07	-.96353235E-10
-.81235041E-06	-.18225686E-07	.86409724E-06	.81421980E-07	-.11449558E-06
.54977989E-09	-.38611032E-09	.12072820E-07	.17167179E-01	-.84177208E-02
.13940941E-07	-.83848781E-09	.30068531E-10	.41762028E-01	.19728023E-08
-.12993543E-08	.27395597E-01	-.22608848E+00	.12966222E+00	.46893542E-10

-.50488788E-08	.25689226E-08	-.32032115E-08	-.12223122E+00	.82113856E-01
.75550354E-12	-.67488837E-07	.40301963E-07	-.71900559E-10	.58945067E-07
-.24482274E-07	.14363279E-09	-.58936241E-11	.14505988E-10	.33385669E-02
-.45134366E-09	.30239391E-09	.32020344E-03	.31906173E-09	.34199546E-11
-.81669645E-08	-.30329414E-06	-.66271809E-06	-.35363609E-09	-.66144997E-06
.30804574E-06	.20159786E-09	-.57170319E-09	-.11035564E-08	-.72527212E-02
.10976139E-08	-.57328140E-09	-.29238966E-02	.21301848E+00	.18980035E+01
.16449225E-07	-.19035792E+01	.15542683E+00	.27743136E-08	.65246642E-06
-.17160470E-06	.41382889E-12	.71710619E-08	.46661594E-06	-.20025118E-06
.22074571E-06	.15404011E-07	.27221783E-06	-.36247494E-05	.29293728E-06
.11631316E-12	-.92446699E-02	-.36511561E+00	.12675867E-07	.36422996E+00
.27036148E-01	-.14001264E-08	.34175860E-07	-.90726267E-08	-.25781137E-13
.51059035E-07	.57298172E-07	-.20698406E-13	-.54019335E-08	.52857311E-07
-.69439023E-07	-.10482756E-07	.36015513E-08	-.59618938E-07	.63686977E-06
-.54634427E-06	-.37138548E-15	-.14881036E-07	-.20788290E-08	.53416876E-14
.49434274E-06	-.52138355E-06	.36084625E-15	.38245326E-02	-.95707833E-02
-.28472227E-09	.95706411E-02	.38248253E-02	-.52950837E-10	.42306378E-10
.13863650E-08	-.83012671E-08	-.31906173E-09	-.34199546E-11	.81669645E-08
-.87485007E-08	-.13865777E-08	.21238779E-14	-.17696591E+00	-.39083612E+00
-.84602464E-10	-.39083720E+00	.17696374E+00	.30775127E-10	.12256099E-08
.79443691E-09	.63405973E-08	.15032889E-07	-.80204827E-08	.24197572E-08
.15146456E-06	.22667613E-06	.27864015E+00	.12645160E-06	.20146267E-06
.74812742E+00	.23320671E-01	.71358750E-01	-.15696020E-06	-.65869035E-07
-.31119132E-06	.19170180E-07	.28954207E-06	-.78314182E-07	-.29898828E-08
.31447785E-08	.59196241E-08	-.10223336E-07	.57668967E-08	.84437859E-08
.19320351E-01	-.48725385E-08	-.12206505E-07	.11866768E+00	.30017386E-01
.48004147E-01	.21394263E-07	-.94233533E-10	-.50069943E-09	-.11013082E-06
-.39767875E-07	-.76296204E-08	.21121434E-08	.98494637E-07	-.30215091E-07
-.83151351E-09	-.86753266E-08	-.74221774E-08	-.46945470E-08	-.49700530E-01
-.27168256E+00	-.17278504E-09	-.72258733E-08	-.45094717E-08	-.82984545E-09
.26263013E-09	.59806850E-09	-.30586106E-02	-.80178997E-09	-.17350601E-08
-.65747891E-02	.56730240E-07	.96467007E-07	.10535633E-09	.30329414E-06
.66271809E-06	.35363609E-09	.17696591E+00	.39083612E+00	.84602464E-10
.34515937E-11	.11639133E-10	.11823240E-03	.78122412E-12	-.14089096E-10
-.72836582E-02	-.46789915E-08	-.15892413E-07	.65356843E-10	.31383227E-07
.10485630E-07	.42666551E-09	.22686122E-06	-.15001301E-06	.75692354E+00
.20000508E-06	-.12631014E-06	-.30143385E+00	.71358882E-01	-.23320214E-01
.38814806E-07	.48891040E-08	.41439984E-06	.18152134E-07	-.42591726E-06
.27558297E-07	.32855064E-08	.49032229E-08	-.29885627E-08	-.83085912E-07
.83112891E-08	-.55592945E-08	.12118342E+00	-.12399628E-07	.47190946E-08
-.31250391E-01	.48004340E-01	-.30017176E-01	.16597444E-08	-.50976879E-11
.19275352E-09	-.15874235E-08	-.11553120E-06	-.45920329E-07	.21718772E-07
-.11154142E-06	.12729912E-07	.22012824E-08	-.16797908E-07	.91574736E-08
-.19556552E-08	-.27168278E+00	.49698521E-01	.46204715E-10	-.11398262E-07
.86245755E-08	.84823258E-08	.60005167E-09	-.27669342E-09	-.65749091E-02
-.17209949E-08	.80376640E-09	.30587738E-02	.91711930E-07	-.55460535E-07
.51525169E-09	.66144997E-06	-.30804574E-06	-.20159786E-09	.39083720E+00
-.17696374E+00	-.30775127E-10	-.78122412E-12	.14089096E-10	.72836582E-02
-.14618963E-09	.69521649E-10	.11823684E-03	-.73228149E-08	-.29478674E-07
.22679544E-09	.44642344E-07	-.22809491E-07	.59107460E-10	-.85227134E-07
-.54382657E-06	.11012196E-05	.10593951E-05	.15030137E-05	.77536846E-05
-.47261019E-08	-.11104159E-07	.25209767E-06	.76837879E-08	.16366625E-07
.11419001E+00	.22910605E-07	.48721700E-07	.94812449E-01	-.26910936E-01
-.53138454E-01	.10396571E-06	-.37021885E-07	.17801169E-06	.12499195E-06
-.23088390E-06	.32957092E-07	.37125093E-06	-.15204283E-09	.22344016E-10
-.41855726E-07	.41887505E-02	.31354146E-01	.46431865E-07	-.44647683E-09
-.16416114E-08	.28098883E-01	.20575968E-08	.54136933E-08	-.80118470E-01
-.19954144E+00	-.51982556E+00	-.11311457E-09	.72402280E-09	.51155317E-09
-.66103844E-08	-.20012965E+00	-.34933873E+00	-.29523672E-11	-.13037445E-06
-.21701737E-06	-.12705909E-09	.65962710E-07	.12765379E-06	-.24445245E-09
.43381873E-11	.92974491E-11	.29258756E-02	.57170319E-09	.11035564E-08
.72527212E-02	-.12256099E-08	-.79443691E-09	-.63405973E-08	.46789915E-08
.15892413E-07	-.65356843E-10	.73228149E-08	.29478674E-07	-.22679544E-09
-.20205244E-11	-.39891324E-11	.87155679E-04	.84364044E-11	.86915796E-11
.68614717E-02	-.35436475E-07	-.14708492E-05	-.62332048E-06	-.10054546E-06
.52218327E-06	.39275247E-05	.82271192E-08	-.34017979E-08	.17927404E-06
-.16399263E-07	.73058140E-08	-.94493068E-01	-.48349038E-07	.22872252E-07
.11390138E+00	.53141657E-01	-.26904645E-01	.94708623E-07	.55451004E-07
.26193636E-06	-.18332552E-07	-.35360159E-06	-.28254188E-07	.38520272E-07
-.19779770E-08	.13203123E-08	-.89135235E-08	-.31354628E-01	.41849538E-02
-.36824273E-07	.16609482E-08	-.44578552E-09	-.79066663E-01	-.54141545E-08

```
 .20376560E-08 -.24921274E-01  .51984922E+00 -.19947944E+00 -.51066096E-10
 .10387562E-07 -.27226537E-08  .73095770E-08  .34936258E+00 -.20008846E+00
 .35514320E-11  .21430064E-06 -.12189418E-06  .18933107E-09 -.13611625E-06
 .63215067E-07 -.27202374E-09 -.76083731E-11 -.16981023E-11 -.72526267E-02
-.10976139E-08  .57328140E-09  .29238966E-02 -.15032889E-07  .80204827E-08
-.24197572E-08 -.31383227E-07 -.10485630E-07 -.42666551E-09 -.44642344E-07
 .22809491E-07 -.59107460E-10 -.84364044E-11 -.86915796E-11 -.68614717E-02
-.10375733E-09  .53480837E-10  .87160403E-04
kdyic1
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00
rvtor1
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00

(and more)
```

isc3_flex_verneq.int (Concept 1) Vernal Equinox

```
TREETOPS REV 10P2  4/10/00

            SIM CONTROL

  1 SI    0 Title                                  ISC MODEL, THIRD VERSION
  2 SI    0 Simulation stop time                   1000000
```

```
  3 SI    0 Plot data interval                                  20
  4 SI    0 Integration type (R,S,U, OR V)                      R
  5 SI    0 Step size (sec)                                     .1
  6 SI    0 Sandia ODE solver absolute and relative error
  7 SI    0 RK78 ODE solver absolute error and first step size
  8 SI    0 Linearization option  (L,Z or N)                    N
  9 SI    0 Restart option          (Y/N)                       N
 10 SI    0 Contact force computation option      (Y/N)        Y
 11 SI    0 Constraint force computation option  (Y/N)        N
 12 SI    0 Small angle speedup option (All,Bypass,First,Nth)  A
 13 SI    0 Mass matrix speedup option (All,Bypass,First,Nth)  A
 14 SI    0 Non-Linear  speedup option (All,Bypass,First,Nth)  A
 15 SI    0 Constraint  speedup option (All,Bypass,First,Nth)  A
 16 SI    0 Constraint stabilization option  (Y/N)             N
 17 SI    0 Stabilization epsilon


            GENGRAV

 18 GG    0 Gravity, earth sphere/nonsphere/user (S/N/U)?      N
 19 GG    1 Input gravity constants:  GME, ERAD, EMASS
 20 GG    1 Spherical or Nonspherical (S/N)?
 21 GG    1 Gravity Potential Harmonics J2,J3,J4
 22 GG    0 English (ft-slug-s) or metric (m-kg-s)    (E/M)?   M
 23 GG    0 Day, Month, Year,                                   20 3 2020
 24 GG    0 GMT @ sim time 0 (minutes past midnight,            360
 25 GG    0 Solar Pressure forces Y/N?                          Y
 26 GG    0 Input new data for aero model? (Y/N)                N
 27 GG    1   Solar flux F10 for aero model
 28 GG    1   Solar flux, 81 day average F10B
 29 GG    1   Geomagnetic index, GEAP


            BODY

 30 BO    1 Body ID number                                      1
 31 BO    1 Type (Rigid,Flexible,NASTRAN)                       F
 32 BO    1 Number of modes                                     24
 33 BO    1 Modal calculation option (0, 1 or 2)                2
 34 BO    1 Foreshortening option (Y/N)
 35 BO    1 Model reduction method (NO,MS,MC,CC,QM,CV)
 36 BO    1 NASTRAN data file FORTRAN unit number (40 - 60)
 37 BO    1 Number of augmented nodes (0 if none)
 38 BO    1 Damping matrix option (NS,CD,HL,SD)
 39 BO    1 Constant damping ratio
 40 BO    1 Low frequency, High frequency ratios
 41 BO    1 Mode ID number, damping ratio
 42 BO    1 Conversion factors: Length,Mass,Force
 43 BO    1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 44 BO    1 Moments of inertia (kg-m2) Ixx,Iyy,Izz              6.2852173E11 6.2852173E11
6.7057352E8
 45 BO    1 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 46 BO    1 Mass (kg)                                           1.6168633E5
 47 BO    1 Number of Nodes                                     4
 48 BO    1 Node ID, Node coord. (meters) x,y,z                 1 0 0 0
 49 BO    1 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
 50 BO    1 Node ID, Node coord. (meters) x,y,z                 3 0 0 3188.8
 51 BO    1 Node ID, Node coord. (meters) x,y,z                 4 0 0 -3188.8
 52 BO    1 Node ID, Node structual joint ID

 53 BO    2 Body ID number                                      2
 54 BO    2 Type (Rigid,Flexible,NASTRAN)                       R
 55 BO    2 Number of modes
 56 BO    2 Modal calculation option (0, 1 or 2)
 57 BO    2 Foreshortening option (Y/N)
 58 BO    2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO    2 NASTRAN data file FORTRAN unit number (40 - 60)
```

```
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz            .8543E12 1.5601E12
1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0 0 0
 69 BO   2 Mass (kg)                                          12666300
 70 BO   2 Number of Nodes                                    5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                     3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                      R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0 0 0
 93 BO   3 Mass (kg)                                          2046600
 94 BO   3 Number of Nodes                                    2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                     4
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                      R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
110 BO   4 Conversion factors: Length,Mass,Force
111 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
112 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1.7E12 1.7E12 3.4E12
113 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0 0 0
114 BO   4 Mass (kg)                                          2046600
115 BO   4 Number of Nodes                                    2
116 BO   4 Node ID, Node coord. (meters) x,y,z                1 0 0 0
117 BO   4 Node ID, Node coord. (meters) x,y,z                2 0 0 0
118 BO   4 Node ID, Node structual joint ID

           HINGE


119 HI   1 Hinge ID number                                    1
120 HI   1 Inboard body ID, Outboard body ID                  0 1
121 HI   1 "p" node ID, "q" node ID                           0 2
122 HI   1 Number of rotation DOFs, Rotation option (F or G)  3 F
123 HI   1 L1 unit vector in inboard body coord. x,y,z        1 0 0
```

124	HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125	HI	1	L2 unit vector in inboard body coord. x,y,z	
126	HI	1	L2 unit vector in outboard body coord. x,y,z	
127	HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128	HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129	HI	1	Initial rotation angles (deg)	-90. 0. 0.
130	HI	1	Initial rotation rates (deg/sec)	0 0 0
131	HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132	HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133	HI	1	Null torque angles (deg)	0 0 0
134	HI	1	Number of translation DOFs	3
135	HI	1	First translation unit vector g1	1 0 0
136	HI	1	Second translation unit vector g2	0 1 0
137	HI	1	Third translation unit vector g3	0 0 1
138	HI	1	Initial translation (meters)	0 0 42163421
139	HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140	HI	1	Translation stiffness (newtons/meters)	0 0 0
141	HI	1	Translation damping (newtons/meter/sec)	0 0 0
142	HI	1	Null force translations	0 0 0
143	HI	2	Hinge ID number	2
144	HI	2	Inboard body ID, Outboard body ID	1 2
145	HI	2	"p" node ID, "q" node ID	2 2
146	HI	2	Number of rotation DOFs	1
147	HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148	HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149	HI	2	L2 unit vector in inboard body coord. x,y,z	
150	HI	2	L2 unit vector in outboard body coord. x,y,z	
151	HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152	HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153	HI	2	Initial rotation angles (deg)	90. 0. 0.
154	HI	2	Initial rotation rates (deg/sec)	0.00417807
155	HI	2	Rotation stiffness (newton-meters/rad)	0
156	HI	2	Rotation damping (newton-meters/rad/sec)	0
157	HI	2	Null torque angles (deg)	0
158	HI	2	Number of translation DOFs	0
159	HI	2	First translation unit vector g1	1 0 0
160	HI	2	Second translation unit vector g2	0 1 0
161	HI	2	Third translation unit vector g3	0 0 1
162	HI	2	Initial translation (meters)	0 0 0
163	HI	2	Initial translation velocity (meters/sec)	
164	HI	2	Translation stiffness (newtons/meters)	
165	HI	2	Translation damping (newtons/meter/sec)	
166	HI	2	Null force translations	
167	HI	3	Hinge ID number	3
168	HI	3	Inboard body ID, Outboard body ID	1 3
169	HI	3	"p" node ID, "q" node ID	3 2
170	HI	3	Number of rotation DOFs	0
171	HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172	HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173	HI	3	L2 unit vector in inboard body coord. x,y,z	
174	HI	3	L2 unit vector in outboard body coord. x,y,z	
175	HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176	HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177	HI	3	Initial rotation angles (deg)	0. 0. -135.
178	HI	3	Initial rotation rates (deg/sec)	
179	HI	3	Rotation stiffness (newton-meters/rad)	
180	HI	3	Rotation damping (newton-meters/rad/sec)	
181	HI	3	Null torque angles (deg)	
182	HI	3	Number of translation DOFs	0
183	HI	3	First translation unit vector g1	1 0 0
184	HI	3	Second translation unit vector g2	0 1 0
185	HI	3	Third translation unit vector g3	0 0 1
186	HI	3	Initial translation (meters)	0 0 0
187	HI	3	Initial translation velocity (meters/sec)	
188	HI	3	Translation stiffness (newtons/meters)	
189	HI	3	Translation damping (newtons/meter/sec)	
190	HI	3	Null force translations	
191	HI	4	Hinge ID number	4

192	HI	4	Inboard body ID, Outboard body ID	1 4
193	HI	4	"p" node ID, "q" node ID	4 2
194	HI	4	Number of rotation DOFs	0
195	HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196	HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197	HI	4	L2 unit vector in inboard body coord. x,y,z	
198	HI	4	L2 unit vector in outboard body coord. x,y,z	
199	HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200	HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201	HI	4	Initial rotation angles (deg)	0. 0. -45.
202	HI	4	Initial rotation rates (deg/sec)	
203	HI	4	Rotation stiffness (newton-meters/rad)	
204	HI	4	Rotation damping (newton-meters/rad/sec)	
205	HI	4	Null torque angles (deg)	
206	HI	4	Number of translation DOFs	0
207	HI	4	First translation unit vector g1	1 0 0
208	HI	4	Second translation unit vector g2	0 1 0
209	HI	4	Third translation unit vector g3	0 0 1
210	HI	4	Initial translation (meters)	0 0 0
211	HI	4	Initial translation velocity (meters/sec)	
212	HI	4	Translation stiffness (newtons/meters)	
213	HI	4	Translation damping (newtons/meter/sec)	
214	HI	4	Null force translations	

SENSOR

215	SE	1	Sensor ID number	1
216	SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217	SE	1	Mounting point body ID, Mounting point node ID	2 2
218	SE	1	Second mounting point body ID, Second node ID	
219	SE	1	Input axis unit vector (IA) x,y,z	
220	SE	1	Mounting point Hinge index, Axis index	
221	SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222	SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223	SE	1	Sun/Star unit vector (Us) x,y,z	
224	SE	1	Velocity Aberration Option (Y/N)	
225	SE	1	Euler Angle Sequence (1-6)	
226	SE	1	CMG ID number and Gimbal number	
227	SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228	SE	2	Sensor ID number	2
229	SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230	SE	2	Mounting point body ID, Mounting point node ID	2 2
231	SE	2	Second mounting point body ID, Second node ID	
232	SE	2	Input axis unit vector (IA) x,y,z	
233	SE	2	Mounting point Hinge index, Axis index	
234	SE	2	First focal plane unit vector (Fp1) x,y,z	0 -1 0
235	SE	2	Second focal plane unit vector (Fp2) x,y,z	1 0 0
236	SE	2	Sun/Star unit vector (Us) x,y,z	0 1 0
237	SE	2	Velocity Aberration Option (Y/N)	N
238	SE	2	Euler Angle Sequence (1-6)	
239	SE	2	CMG ID number and Gimbal number	
240	SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
241	SE	3	Sensor ID number	3
242	SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
243	SE	3	Mounting point body ID, Mounting point node ID	1 2
244	SE	3	Second mounting point body ID, Second node ID	
245	SE	3	Input axis unit vector (IA) x,y,z	
246	SE	3	Mounting point Hinge index, Axis index	
247	SE	3	First focal plane unit vector (Fp1) x,y,z	-1 0 0
248	SE	3	Second focal plane unit vector (Fp2) x,y,z	0 0 1
249	SE	3	Sun/Star unit vector (Us) x,y,z	0 0 0
250	SE	3	Velocity Aberration Option (Y/N)	N
251	SE	3	Euler Angle Sequence (1-6)	
252	SE	3	CMG ID number and Gimbal number	
253	SE	3	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254	SE	4	Sensor ID number	4
255	SE	4	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	A3

```
256 SE   4 Mounting point body ID, Mounting point node ID      1 2
257 SE   4 Second mounting point body ID, Second node ID
258 SE   4 Input axis unit vector (IA) x,y,z
259 SE   4 Mounting point Hinge index, Axis index
260 SE   4 First focal plane unit vector  (Fp1) x,y,z
261 SE   4 Second focal plane unit vector (Fp2) x,y,z
262 SE   4 Sun/Star unit vector (Us) x,y,z
263 SE   4 Velocity Aberration Option (Y/N)
264 SE   4 Euler Angle Sequence (1-6)
265 SE   4 CMG ID number and Gimbal number
266 SE   4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE   5 Sensor ID number                                     5
268 SE   5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)  LV
269 SE   5 Mounting point body ID, Mounting point node ID      1 2
270 SE   5 Second mounting point body ID, Second node ID
271 SE   5 Input axis unit vector (IA) x,y,z
272 SE   5 Mounting point Hinge index, Axis index
273 SE   5 First focal plane unit vector  (Fp1) x,y,z
274 SE   5 Second focal plane unit vector (Fp2) x,y,z
275 SE   5 Sun/Star unit vector (Us) x,y,z
276 SE   5 Velocity Aberration Option (Y/N)
277 SE   5 Euler Angle Sequence (1-6)
278 SE   5 CMG ID number and Gimbal number
279 SE   5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE   6 Sensor ID number                                     6
281 SE   6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV  L
282 SE   6 Mounting point body ID, Mounting point node ID      3 2
283 SE   6 Second mounting point body ID, Second node ID
284 SE   6 Input axis unit vector (IA) x,y,z                   1 0 0
285 SE   6 Mounting point Hinge index, Axis index
286 SE   6 First focal plane unit vector  (Fp1) x,y,z
287 SE   6 Second focal plane unit vector (Fp2) x,y,z
288 SE   6 Sun/Star unit vector (Us) x,y,z
289 SE   6 Velocity Aberration Option (Y/N)
290 SE   6 Euler Angle Sequence (1-6)
291 SE   6 CMG ID number and Gimbal number
292 SE   6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE   7 Sensor ID number                                     7
294 SE   7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV  L
295 SE   7 Mounting point body ID, Mounting point node ID      4 2
296 SE   7 Second mounting point body ID, Second node ID
297 SE   7 Input axis unit vector (IA) x,y,z                   1 0 0
298 SE   7 Mounting point Hinge index, Axis index
299 SE   7 First focal plane unit vector  (Fp1) x,y,z
300 SE   7 Second focal plane unit vector (Fp2) x,y,z
301 SE   7 Sun/Star unit vector (Us) x,y,z
302 SE   7 Velocity Aberration Option (Y/N)
303 SE   7 Euler Angle Sequence (1-6)
304 SE   7 CMG ID number and Gimbal number
305 SE   7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

           ACTR

306 AC   1 Actuator ID number                                   1
307 AC   1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
308 AC   1 Actuator location; Node or Hinge (N or H)
309 AC   1 Mounting point body ID number, node ID number       2 2
310 AC   1 Second mounting point body ID, second node ID
311 AC   1 Output axis unit vector x,y,z                       0 1 0
312 AC   1 Mounting point Hinge index, Axis index
313 AC   1 Rotor spin axis unit vector x,y,z
314 AC   1 Initial rotor momentum, H
315 AC   1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
316 AC   1 Outer gimbal axis unit vector x,y,z
317 AC   1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
318 AC   1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
319 AC   1 Inner gimbal axis unit vector x,y,z
```

```
320 AC   1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
321 AC   1 Initial length and rate, y(to) and ydot(to)
322 AC   1 Constants; K1 or wo, n or zeta, Kg, Jm
323 AC   1 Non-linearities; TLim, Tco, Dz

324 AC   2 Actuator ID number                                  2
325 AC   2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
326 AC   2 Actuator location; Node or Hinge (N or H)
327 AC   2 Mounting point body ID number, node ID number       2 2
328 AC   2 Second mounting point body ID, second node ID
329 AC   2 Output axis unit vector x,y,z                       0 0 1
330 AC   2 Mounting point Hinge index, Axis index
331 AC   2 Rotor spin axis unit vector x,y,z
332 AC   2 Initial rotor momentum, H
333 AC   2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
334 AC   2 Outer gimbal axis unit vector x,y,z
335 AC   2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
336 AC   2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
337 AC   2 Inner gimbal axis unit vector x,y,z
338 AC   2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
339 AC   2 Initial length and rate, y(to) and ydot(to)
340 AC   2 Constants; K1 or wo, n or zeta, Kg, Jm
341 AC   2 Non-linearities; TLim, Tco, Dz

342 AC   3 Actuator ID number                                  3
343 AC   3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
344 AC   3 Actuator location; Node or Hinge (N or H)
345 AC   3 Mounting point body ID number, node ID number       2 2
346 AC   3 Second mounting point body ID, second node ID
347 AC   3 Output axis unit vector x,y,z                       1 0 0
348 AC   3 Mounting point Hinge index, Axis index
349 AC   3 Rotor spin axis unit vector x,y,z
350 AC   3 Initial rotor momentum, H
351 AC   3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
352 AC   3 Outer gimbal axis unit vector x,y,z
353 AC   3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
354 AC   3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
355 AC   3 Inner gimbal axis unit vector x,y,z
356 AC   3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
357 AC   3 Initial length and rate, y(to) and ydot(to)
358 AC   3 Constants; K1 or wo, n or zeta, Kg, Jm
359 AC   3 Non-linearities; TLim, Tco, Dz

360 AC   4 Actuator ID number                                  4
361 AC   4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 T
362 AC   4 Actuator location; Node or Hinge (N or H)
363 AC   4 Mounting point body ID number, node ID number
364 AC   4 Second mounting point body ID, second node ID
365 AC   4 Output axis unit vector x,y,z
366 AC   4 Mounting point Hinge index, Axis index              2 1
367 AC   4 Rotor spin axis unit vector x,y,z
368 AC   4 Initial rotor momentum, H
369 AC   4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
370 AC   4 Outer gimbal axis unit vector x,y,z
371 AC   4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
372 AC   4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
373 AC   4 Inner gimbal axis unit vector x,y,z
374 AC   4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
375 AC   4 Initial length and rate, y(to) and ydot(to)
376 AC   4 Constants; K1 or wo, n or zeta, Kg, Jm
377 AC   4 Non-linearities; TLim, Tco, Dz

378 AC   5 Actuator ID number                                  5
379 AC   5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)              J
380 AC   5 Actuator location; Node or Hinge (N or H)
381 AC   5 Mounting point body ID number, node ID number       2 5
382 AC   5 Second mounting point body ID, second node ID
383 AC   5 Output axis unit vector x,y,z                       -1 0 0
384 AC   5 Mounting point Hinge index, Axis index
385 AC   5 Rotor spin axis unit vector x,y,z
386 AC   5 Initial rotor momentum, H
```

```
387 AC   5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
388 AC   5 Outer gimbal axis unit vector x,y,z
389 AC   5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
390 AC   5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
391 AC   5 Inner gimbal axis unit vector x,y,z
392 AC   5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
393 AC   5 Initial length and rate, y(to) and ydot(to)
394 AC   5 Constants; K1 or wo, n or zeta, Kg, Jm
395 AC   5 Non-linearities; TLim, Tco, Dz

           CONTROLLER

396 CO   1 Controller ID number                                 1
397 CO   1 Controller type (CB,CM,DB,DM,UC,UD)                  CM
398 CO   1 Sample time (sec)
399 CO   1 Number of inputs, Number of outputs                  4 4
400 CO   1 Number of states
401 CO   1 Output No., Input type (I,S,T), Input ID, Gain

           INTERCONNECT

402 IN   1 Interconnect ID number                               1
403 IN   1 Source type(S,C, or F),Source ID,Source row #        S 1 1
404 IN   1 Destination type(A or C),Dest ID,Dest row #          C 1 1
405 IN   1 Gain                                                 4.41E13

406 IN   2 Interconnect ID number                               2
407 IN   2 Source type(S,C, or F),Source ID,Source row #        C 1 1
408 IN   2 Destination type(A or C),Dest ID,Dest row #          A 1 1
409 IN   2 Gain                                                 1

410 IN   3 Interconnect ID number                               3
411 IN   3 Source type(S,C, or F),Source ID,Source row #        S 1 2
412 IN   3 Destination type(A or C),Dest ID,Dest row #          C 1 2
413 IN   3 Gain                                                 1.67E12

414 IN   4 Interconnect ID number                               4
415 IN   4 Source type(S,C, or F),Source ID,Source row #        C 1 2
416 IN   4 Destination type(A or C),Dest ID,Dest row #          A 2 1
417 IN   4 Gain                                                 1

418 IN   5 Interconnect ID number                               5
419 IN   5 Source type(S,C, or F),Source ID,Source row #        S 2 1
420 IN   5 Destination type(A or C),Dest ID,Dest row #          C 1 3
421 IN   5 Gain                                                 4.31E13

422 IN   6 Interconnect ID number                               6
423 IN   6 Source type(S,C, or F),Source ID,Source row #        C 1 3
424 IN   6 Destination type(A or C),Dest ID,Dest row #          A 3 1
425 IN   6 Gain                                                 1

426 IN   7 Interconnect ID number                               7
427 IN   7 Source type(S,C, or F),Source ID,Source row #        S 3 1
428 IN   7 Destination type(A or C),Dest ID,Dest row #          C 1 4
429 IN   7 Gain                                                 6.7E8

430 IN   8 Interconnect ID number                               8
431 IN   8 Source type(S,C, or F),Source ID,Source row #        C 1 4
432 IN   8 Destination type(A or C),Dest ID,Dest row #          A 4 1
433 IN   8 Gain                                                 1

434 IN   9 Interconnect ID number                               9
435 IN   9 Source type(S,C, or F),Source ID,Source row #        S 3 3
436 IN   9 Destination type(A or C),Dest ID,Dest row #          A 5 1
437 IN   9 Gain                                                 7
```

isc3_flex_autmeq.int (Concept 1) Autumnal Equinox

```
TREETOPS REV 10P2  4/10/00

          SIM CONTROL

 1 SI   0 Title                                             ISC MODEL, THIRD VERSION
 2 SI   0 Simulation stop time                              100000
 3 SI   0 Plot data interval                                20
 4 SI   0 Integration type (R,S,U, OR V)                    R
 5 SI   0 Step size (sec)                                   .1
 6 SI   0 Sandia ODE solver absolute and relative error
 7 SI   0 RK78 ODE solver absolute error and first step size
 8 SI   0 Linearization option  (L,Z or N)                  N
 9 SI   0 Restart option         (Y/N)                      N
10 SI   0 Contact force computation option     (Y/N)        Y
11 SI   0 Constraint force computation option  (Y/N)        N
12 SI   0 Small angle speedup option (All,Bypass,First,Nth) A
13 SI   0 Mass matrix speedup option (All,Bypass,First,Nth) A
14 SI   0 Non-Linear  speedup option (All,Bypass,First,Nth) A
15 SI   0 Constraint  speedup option (All,Bypass,First,Nth) A
16 SI   0 Constraint stabilization option  (Y/N)            N
17 SI   0 Stabilization epsilon

          GENGRAV

18 GG   0 Gravity, earth sphere/nonsphere/user (S/N/U)?     N
19 GG   1 Input gravity constants:  GME, ERAD, EMASS
20 GG   1 Spherical or Nonspherical (S/N)?
21 GG   1 Gravity Potential Harmonics J2,J3,J4
22 GG   0 English (ft-slug-s) or metric (m-kg-s)    (E/M)?  M
23 GG   0 Day, Month, Year,                                 20 9 2020
24 GG   0 GMT @ sim time 0 (minutes past midnight,          360
25 GG   0 Solar Pressure forces Y/N?                        Y
26 GG   0 Input new data for aero model? (Y/N)              N
27 GG   1   Solar flux F10 for aero model
28 GG   1   Solar flux, 81 day average F10B
29 GG   1   Geomagnetic index, GEAP

          BODY

30 BO   1 Body ID number                                    1
31 BO   1 Type (Rigid,Flexible,NASTRAN)                     F
32 BO   1 Number of modes                                   24
33 BO   1 Modal calculation option (0, 1 or 2)              2
34 BO   1 Foreshortening option (Y/N)
35 BO   1 Model reduction method (NO,MS,MC,CC,QM,CV)
36 BO   1 NASTRAN data file FORTRAN unit number (40 - 60)
37 BO   1 Number of augmented nodes (0 if none)
38 BO   1 Damping matrix option (NS,CD,HL,SD)
39 BO   1 Constant damping ratio
40 BO   1 Low frequency, High frequency ratios
41 BO   1 Mode ID number, damping ratio
42 BO   1 Conversion factors: Length,Mass,Force
43 BO   1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
44 BO   1 Moments of inertia (kg-m2) Ixx,Iyy,Izz            6.2852173E11 6.2852173E11
6.7057352E8
45 BO   1 Products of inertia (kg-m2) Ixy,Ixz,Iyz           0 0 0
46 BO   1 Mass (kg)                                         1.6168633E5
47 BO   1 Number of Nodes                                   4
48 BO   1 Node ID, Node coord. (meters) x,y,z               1 0 0 0
49 BO   1 Node ID, Node coord. (meters) x,y,z               2 0 0 0
50 BO   1 Node ID, Node coord. (meters) x,y,z               3 0 0 3188.8
51 BO   1 Node ID, Node coord. (meters) x,y,z               4 0 0 -3188.8
52 BO   1 Node ID, Node structual joint ID

53 BO   2 Body ID number                                    2
54 BO   2 Type (Rigid,Flexible,NASTRAN)                     R
```

```
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz             .8543E12 1.5601E12
1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 69 BO   2 Mass (kg)                                           12666300
 70 BO   2 Number of Nodes                                     5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                 1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                 3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                 4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                 5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                      3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                       R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 93 BO   3 Mass (kg)                                           2046600
 94 BO   3 Number of Nodes                                     2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                 1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                      4
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                       R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
110 BO   4 Conversion factors: Length,Mass,Force
111 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
112 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1.7E12 1.7E12 3.4E12
113 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
114 BO   4 Mass (kg)                                           2046600
115 BO   4 Number of Nodes                                     2
116 BO   4 Node ID, Node coord. (meters) x,y,z                 1 0 0 0
117 BO   4 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
118 BO   4 Node ID, Node structual joint ID


         HINGE
```

```
119 HI   1 Hinge ID number                                         1
120 HI   1 Inboard body ID, Outboard body ID                       0 1
121 HI   1 "p" node ID, "q" node ID                                0 2
122 HI   1 Number of rotation DOFs, Rotation option (F or G)       3 F
123 HI   1 L1 unit vector in inboard body coord. x,y,z             1 0 0
124 HI   1 L1 unit vector in outboard body coord. x,y,z            1 0 0
125 HI   1 L2 unit vector in inboard body coord. x,y,z
126 HI   1 L2 unit vector in outboard body coord. x,y,z
127 HI   1 L3 unit vector in inboard body coord. x,y,z             0 0 1
128 HI   1 L3 unit vector in outboard body coord. x,y,z            0 0 1
129 HI   1 Initial rotation angles (deg)                           -90. 0. 180.
130 HI   1 Initial rotation rates (deg/sec)                        0 0 0
131 HI   1 Rotation stiffness (newton-meters/rad)                  0 0 0
132 HI   1 Rotation damping (newton-meters/rad/sec)                0 0 0
133 HI   1 Null torque angles (deg)                                0 0 0
134 HI   1 Number of translation DOFs                              3
135 HI   1 First translation unit vector   g1                      1 0 0
136 HI   1 Second translation unit vector  g2                      0 1 0
137 HI   1 Third translation unit vector   g3                      0 0 1
138 HI   1 Initial translation (meters)                            0 0 42163421
139 HI   1 Initial translation velocity (meters/sec)               3074.681 0 0
140 HI   1 Translation stiffness (newtons/meters)                  0 0 0
141 HI   1 Translation damping (newtons/meter/sec)                 0 0 0
142 HI   1 Null force translations                                 0 0 0

143 HI   2 Hinge ID number                                         2
144 HI   2 Inboard body ID, Outboard body ID                       1 2
145 HI   2 "p" node ID, "q" node ID                                2 2
146 HI   2  Number of rotation DOFs                                1
147 HI   2 L1 unit vector in inboard body coord. x,y,z             0 0 1
148 HI   2 L1 unit vector in outboard body coord. x,y,z            0 0 1
149 HI   2 L2 unit vector in inboard body coord. x,y,z
150 HI   2 L2 unit vector in outboard body coord. x,y,z
151 HI   2 L3 unit vector in inboard body coord. x,y,z             1 0 0
152 HI   2 L3 unit vector in outboard body coord. x,y,z            1 0 0
153 HI   2 Initial rotation angles (deg)                           -90. 0. 0.
154 HI   2 Initial rotation rates (deg/sec)                         0.00417807
155 HI   2 Rotation stiffness (newton-meters/rad)                  0
156 HI   2 Rotation damping (newton-meters/rad/sec)                0
157 HI   2 Null torque angles (deg)                                0
158 HI   2 Number of translation DOFs                              0
159 HI   2 First translation unit vector   g1                      1 0 0
160 HI   2 Second translation unit vector  g2                      0 1 0
161 HI   2 Third translation unit vector   g3                      0 0 1
162 HI   2 Initial translation (meters)                            0 0 0
163 HI   2 Initial translation velocity (meters/sec)
164 HI   2 Translation stiffness (newtons/meters)
165 HI   2 Translation damping (newtons/meter/sec)
166 HI   2 Null force translations

167 HI   3 Hinge ID number                                         3
168 HI   3 Inboard body ID, Outboard body ID                       1 3
169 HI   3 "p" node ID, "q" node ID                                3 2
170 HI   3  Number of rotation DOFs                                0
171 HI   3 L1 unit vector in inboard body coord. x,y,z             0 0 1
172 HI   3 L1 unit vector in outboard body coord. x,y,z            0 0 1
173 HI   3 L2 unit vector in inboard body coord. x,y,z
174 HI   3 L2 unit vector in outboard body coord. x,y,z
175 HI   3 L3 unit vector in inboard body coord. x,y,z             0 1 0
176 HI   3 L3 unit vector in outboard body coord. x,y,z            0 1 0
177 HI   3 Initial rotation angles (deg)                           180. 0. -135.
178 HI   3 Initial rotation rates (deg/sec)
179 HI   3 Rotation stiffness (newton-meters/rad)
180 HI   3 Rotation damping (newton-meters/rad/sec)
181 HI   3 Null torque angles (deg)
182 HI   3 Number of translation DOFs                              0
183 HI   3 First translation unit vector   g1                      1 0 0
184 HI   3 Second translation unit vector  g2                      0 1 0
185 HI   3 Third translation unit vector   g3                      0 0 1
186 HI   3 Initial translation (meters)                            0 0 0
```

187	HI	3	Initial translation velocity (meters/sec)	
188	HI	3	Translation stiffness (newtons/meters)	
189	HI	3	Translation damping (newtons/meter/sec)	
190	HI	3	Null force translations	
191	HI	4	Hinge ID number	4
192	HI	4	Inboard body ID, Outboard body ID	1 4
193	HI	4	"p" node ID, "q" node ID	4 2
194	HI	4	Number of rotation DOFs	0
195	HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196	HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197	HI	4	L2 unit vector in inboard body coord. x,y,z	
198	HI	4	L2 unit vector in outboard body coord. x,y,z	
199	HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200	HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201	HI	4	Initial rotation angles (deg)	180. 0 -45.
202	HI	4	Initial rotation rates (deg/sec)	
203	HI	4	Rotation stiffness (newton-meters/rad)	
204	HI	4	Rotation damping (newton-meters/rad/sec)	
205	HI	4	Null torque angles (deg)	
206	HI	4	Number of translation DOFs	0
207	HI	4	First translation unit vector g1	1 0 0
208	HI	4	Second translation unit vector g2	0 1 0
209	HI	4	Third translation unit vector g3	0 0 1
210	HI	4	Initial translation (meters)	0 0 0
211	HI	4	Initial translation velocity (meters/sec)	
212	HI	4	Translation stiffness (newtons/meters)	
213	HI	4	Translation damping (newtons/meter/sec)	
214	HI	4	Null force translations	

SENSOR

215	SE	1	Sensor ID number	1
216	SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217	SE	1	Mounting point body ID, Mounting point node ID	2 2
218	SE	1	Second mounting point body ID, Second node ID	
219	SE	1	Input axis unit vector (IA) x,y,z	
220	SE	1	Mounting point Hinge index, Axis index	
221	SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222	SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223	SE	1	Sun/Star unit vector (Us) x,y,z	
224	SE	1	Velocity Aberration Option (Y/N)	
225	SE	1	Euler Angle Sequence (1-6)	
226	SE	1	CMG ID number and Gimbal number	
227	SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228	SE	2	Sensor ID number	2
229	SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230	SE	2	Mounting point body ID, Mounting point node ID	2 2
231	SE	2	Second mounting point body ID, Second node ID	
232	SE	2	Input axis unit vector (IA) x,y,z	
233	SE	2	Mounting point Hinge index, Axis index	
234	SE	2	First focal plane unit vector (Fp1) x,y,z	0 -1 0
235	SE	2	Second focal plane unit vector (Fp2) x,y,z	1 0 0
236	SE	2	Sun/Star unit vector (Us) x,y,z	0 1 0
237	SE	2	Velocity Aberration Option (Y/N)	N
238	SE	2	Euler Angle Sequence (1-6)	
239	SE	2	CMG ID number and Gimbal number	
240	SE	2	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
241	SE	3	Sensor ID number	3
242	SE	3	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
243	SE	3	Mounting point body ID, Mounting point node ID	1 2
244	SE	3	Second mounting point body ID, Second node ID	
245	SE	3	Input axis unit vector (IA) x,y,z	
246	SE	3	Mounting point Hinge index, Axis index	
247	SE	3	First focal plane unit vector (Fp1) x,y,z	-1 0 0
248	SE	3	Second focal plane unit vector (Fp2) x,y,z	0 0 1
249	SE	3	Sun/Star unit vector (Us) x,y,z	0 0 0
250	SE	3	Velocity Aberration Option (Y/N)	N

```
251 SE   3 Euler Angle Sequence (1-6)
252 SE   3 CMG ID number and Gimbal number
253 SE   3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE   4 Sensor ID number                                    4
255 SE   4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)  A3
256 SE   4 Mounting point body ID, Mounting point node ID      1 2
257 SE   4 Second mounting point body ID, Second node ID
258 SE   4 Input axis unit vector (IA) x,y,z
259 SE   4 Mounting point Hinge index, Axis index
260 SE   4 First focal plane unit vector  (Fp1) x,y,z
261 SE   4 Second focal plane unit vector (Fp2) x,y,z
262 SE   4 Sun/Star unit vector (Us) x,y,z
263 SE   4 Velocity Aberration Option (Y/N)
264 SE   4 Euler Angle Sequence (1-6)
265 SE   4 CMG ID number and Gimbal number
266 SE   4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE   5 Sensor ID number                                    5
268 SE   5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)  LV
269 SE   5 Mounting point body ID, Mounting point node ID      1 2
270 SE   5 Second mounting point body ID, Second node ID
271 SE   5 Input axis unit vector (IA) x,y,z
272 SE   5 Mounting point Hinge index, Axis index
273 SE   5 First focal plane unit vector  (Fp1) x,y,z
274 SE   5 Second focal plane unit vector (Fp2) x,y,z
275 SE   5 Sun/Star unit vector (Us) x,y,z
276 SE   5 Velocity Aberration Option (Y/N)
277 SE   5 Euler Angle Sequence (1-6)
278 SE   5 CMG ID number and Gimbal number
279 SE   5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE   6 Sensor ID number                                    6
281 SE   6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV L
282 SE   6 Mounting point body ID, Mounting point node ID      3 2
283 SE   6 Second mounting point body ID, Second node ID
284 SE   6 Input axis unit vector (IA) x,y,z                   1 0 0
285 SE   6 Mounting point Hinge index, Axis index
286 SE   6 First focal plane unit vector  (Fp1) x,y,z
287 SE   6 Second focal plane unit vector (Fp2) x,y,z
288 SE   6 Sun/Star unit vector (Us) x,y,z
289 SE   6 Velocity Aberration Option (Y/N)
290 SE   6 Euler Angle Sequence (1-6)
291 SE   6 CMG ID number and Gimbal number
292 SE   6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE   7 Sensor ID number                                    7
294 SE   7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV L
295 SE   7 Mounting point body ID, Mounting point node ID      4 2
296 SE   7 Second mounting point body ID, Second node ID
297 SE   7 Input axis unit vector (IA) x,y,z                   1 0 0
298 SE   7 Mounting point Hinge index, Axis index
299 SE   7 First focal plane unit vector  (Fp1) x,y,z
300 SE   7 Second focal plane unit vector (Fp2) x,y,z
301 SE   7 Sun/Star unit vector (Us) x,y,z
302 SE   7 Velocity Aberration Option (Y/N)
303 SE   7 Euler Angle Sequence (1-6)
304 SE   7 CMG ID number and Gimbal number
305 SE   7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

           ACTR

306 AC   1 Actuator ID number                                  1
307 AC   1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
308 AC   1 Actuator location; Node or Hinge (N or H)
309 AC   1 Mounting point body ID number, node ID number       2 2
310 AC   1 Second mounting point body ID, second node ID
311 AC   1 Output axis unit vector x,y,z                       0 1 0
312 AC   1 Mounting point Hinge index, Axis index
313 AC   1 Rotor spin axis unit vector x,y,z
```

314	AC	1	Initial rotor momentum, H	
315	AC	1	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
316	AC	1	Outer gimbal axis unit vector x,y,z	
317	AC	1	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318	AC	1	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
319	AC	1	Inner gimbal axis unit vector x,y,z	
320	AC	1	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321	AC	1	Initial length and rate, y(to) and ydot(to)	
322	AC	1	Constants; K1 or wo, n or zeta, Kg, Jm	
323	AC	1	Non-linearities; TLim, Tco, Dz	
324	AC	2	Actuator ID number	2
325	AC	2	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326	AC	2	Actuator location; Node or Hinge (N or H)	
327	AC	2	Mounting point body ID number, node ID number	2 2
328	AC	2	Second mounting point body ID, second node ID	
329	AC	2	Output axis unit vector x,y,z	0 0 1
330	AC	2	Mounting point Hinge index, Axis index	
331	AC	2	Rotor spin axis unit vector x,y,z	
332	AC	2	Initial rotor momentum, H	
333	AC	2	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334	AC	2	Outer gimbal axis unit vector x,y,z	
335	AC	2	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336	AC	2	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337	AC	2	Inner gimbal axis unit vector x,y,z	
338	AC	2	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339	AC	2	Initial length and rate, y(to) and ydot(to)	
340	AC	2	Constants; K1 or wo, n or zeta, Kg, Jm	
341	AC	2	Non-linearities; TLim, Tco, Dz	
342	AC	3	Actuator ID number	3
343	AC	3	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344	AC	3	Actuator location; Node or Hinge (N or H)	
345	AC	3	Mounting point body ID number, node ID number	2 2
346	AC	3	Second mounting point body ID, second node ID	
347	AC	3	Output axis unit vector x,y,z	1 0 0
348	AC	3	Mounting point Hinge index, Axis index	
349	AC	3	Rotor spin axis unit vector x,y,z	
350	AC	3	Initial rotor momentum, H	
351	AC	3	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
352	AC	3	Outer gimbal axis unit vector x,y,z	
353	AC	3	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354	AC	3	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
355	AC	3	Inner gimbal axis unit vector x,y,z	
356	AC	3	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357	AC	3	Initial length and rate, y(to) and ydot(to)	
358	AC	3	Constants; K1 or wo, n or zeta, Kg, Jm	
359	AC	3	Non-linearities; TLim, Tco, Dz	
360	AC	4	Actuator ID number	4
361	AC	4	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	T
362	AC	4	Actuator location; Node or Hinge (N or H)	
363	AC	4	Mounting point body ID number, node ID number	
364	AC	4	Second mounting point body ID, second node ID	
365	AC	4	Output axis unit vector x,y,z	
366	AC	4	Mounting point Hinge index, Axis index	2 1
367	AC	4	Rotor spin axis unit vector x,y,z	
368	AC	4	Initial rotor momentum, H	
369	AC	4	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
370	AC	4	Outer gimbal axis unit vector x,y,z	
371	AC	4	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
372	AC	4	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
373	AC	4	Inner gimbal axis unit vector x,y,z	
374	AC	4	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
375	AC	4	Initial length and rate, y(to) and ydot(to)	
376	AC	4	Constants; K1 or wo, n or zeta, Kg, Jm	
377	AC	4	Non-linearities; TLim, Tco, Dz	
378	AC	5	Actuator ID number	5
379	AC	5	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
380	AC	5	Actuator location; Node or Hinge (N or H)	

381	AC	5	Mounting point body ID number, node ID number	2 5
382	AC	5	Second mounting point body ID, second node ID	
383	AC	5	Output axis unit vector x,y,z	-1 0 0
384	AC	5	Mounting point Hinge index, Axis index	
385	AC	5	Rotor spin axis unit vector x,y,z	
386	AC	5	Initial rotor momentum, H	
387	AC	5	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388	AC	5	Outer gimbal axis unit vector x,y,z	
389	AC	5	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390	AC	5	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391	AC	5	Inner gimbal axis unit vector x,y,z	
392	AC	5	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393	AC	5	Initial length and rate, y(to) and ydot(to)	
394	AC	5	Constants; K1 or wo, n or zeta, Kg, Jm	
395	AC	5	Non-linearities; TLim, Tco, Dz	

CONTROLLER

396	CO	1	Controller ID number	1
397	CO	1	Controller type (CB,CM,DB,DM,UC,UD)	CM
398	CO	1	Sample time (sec)	
399	CO	1	Number of inputs, Number of outputs	4 4
400	CO	1	Number of states	
401	CO	1	Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

402	IN	1	Interconnect ID number	1
403	IN	1	Source type(S,C, or F),Source ID,Source row #	S 1 1
404	IN	1	Destination type(A or C),Dest ID,Dest row #	C 1 1
405	IN	1	Gain	4.41E13
406	IN	2	Interconnect ID number	2
407	IN	2	Source type(S,C, or F),Source ID,Source row #	C 1 1
408	IN	2	Destination type(A or C),Dest ID,Dest row #	A 1 1
409	IN	2	Gain	1
410	IN	3	Interconnect ID number	3
411	IN	3	Source type(S,C, or F),Source ID,Source row #	S 1 2
412	IN	3	Destination type(A or C),Dest ID,Dest row #	C 1 2
413	IN	3	Gain	1.67E12
414	IN	4	Interconnect ID number	4
415	IN	4	Source type(S,C, or F),Source ID,Source row #	C 1 2
416	IN	4	Destination type(A or C),Dest ID,Dest row #	A 2 1
417	IN	4	Gain	1
418	IN	5	Interconnect ID number	5
419	IN	5	Source type(S,C, or F),Source ID,Source row #	S 2 1
420	IN	5	Destination type(A or C),Dest ID,Dest row #	C 1 3
421	IN	5	Gain	4.31E13
422	IN	6	Interconnect ID number	6
423	IN	6	Source type(S,C, or F),Source ID,Source row #	C 1 3
424	IN	6	Destination type(A or C),Dest ID,Dest row #	A 3 1
425	IN	6	Gain	1
426	IN	7	Interconnect ID number	7
427	IN	7	Source type(S,C, or F),Source ID,Source row #	S 3 1
428	IN	7	Destination type(A or C),Dest ID,Dest row #	C 1 4
429	IN	7	Gain	6.7E8
430	IN	8	Interconnect ID number	8
431	IN	8	Source type(S,C, or F),Source ID,Source row #	C 1 4
432	IN	8	Destination type(A or C),Dest ID,Dest row #	A 4 1
433	IN	8	Gain	1
434	IN	9	Interconnect ID number	9
435	IN	9	Source type(S,C, or F),Source ID,Source row #	S 3 3

```
436 IN   9 Destination type(A or C),Dest ID,Dest row #        A 5 1
437 IN   9 Gain                                               7
```

isc3_flex_winsol.int (Concept 1) Winter Solstice

```
TREETOPS REV 10P2  4/10/00

           SIM CONTROL

  1 SI    0 Title                                                 ISC MODEL, THIRD VERSION
  2 SI    0 Simulation stop time                                  100000
  3 SI    0 Plot data interval                                    20
  4 SI    0 Integration type (R,S,U, OR V)                        R
  5 SI    0 Step size (sec)                                       .1
  6 SI    0 Sandia ODE solver absolute and relative error
  7 SI    0 RK78 ODE solver absolute error and first step size
  8 SI    0 Linearization option  (L,Z or N)                      N
  9 SI    0 Restart option        (Y/N)                           N
 10 SI    0 Contact force computation option      (Y/N)           Y
 11 SI    0 Constraint force computation option  (Y/N)            N
 12 SI    0 Small angle speedup option (All,Bypass,First,Nth)     A
 13 SI    0 Mass matrix speedup option (All,Bypass,First,Nth)     A
 14 SI    0 Non-Linear  speedup option (All,Bypass,First,Nth)     A
 15 SI    0 Constraint  speedup option (All,Bypass,First,Nth)     A
 16 SI    0 Constraint stabilization option  (Y/N)                N
 17 SI    0 Stabilization epsilon

           GENGRAV

 18 GG    0 Gravity, earth sphere/nonsphere/user (S/N/U)?         N
 19 GG    1 Input gravity constants:  GME, ERAD, EMASS
 20 GG    1 Spherical or Nonspherical (S/N)?
 21 GG    1 Gravity Potential Harmonics J2,J3,J4
 22 GG    0 English (ft-slug-s) or metric (m-kg-s)    (E/M)?      M
 23 GG    0 Day, Month, Year,                                     20 12 2020
 24 GG    0 GMT @ sim time 0 (minutes past midnight,              360
 25 GG    0 Solar Pressure forces Y/N?                            Y
 26 GG    0 Input new data for aero model? (Y/N)                  N
 27 GG    1   Solar flux F10 for aero model
 28 GG    1   Solar flux, 81 day average F10B
 29 GG    1   Geomagnetic index, GEAP

           BODY

 30 BO    1 Body ID number                                        1
 31 BO    1 Type (Rigid,Flexible,NASTRAN)                         F
 32 BO    1 Number of modes                                       24
 33 BO    1 Modal calculation option (0, 1 or 2)                  2
 34 BO    1 Foreshortening option (Y/N)
 35 BO    1 Model reduction method (NO,MS,MC,CC,QM,CV)
 36 BO    1 NASTRAN data file FORTRAN unit number (40 - 60)
 37 BO    1 Number of augmented nodes (0 if none)
 38 BO    1 Damping matrix option (NS,CD,HL,SD)
 39 BO    1 Constant damping ratio
 40 BO    1 Low frequency, High frequency ratios
 41 BO    1 Mode ID number, damping ratio
 42 BO    1 Conversion factors: Length,Mass,Force
 43 BO    1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 44 BO    1 Moments of inertia (kg-m2) Ixx,Iyy,Izz                6.2852173E11 6.2852173E11
6.7057352E8
 45 BO    1 Products of inertia (kg-m2) Ixy,Ixz,Iyz               0 0 0
 46 BO    1 Mass (kg)                                             1.6168633E5
 47 BO    1 Number of Nodes                                       4
```

```
 48 BO   1 Node ID, Node coord. (meters) x,y,z                     1 0 0 0
 49 BO   1 Node ID, Node coord. (meters) x,y,z                     2 0 0 0
 50 BO   1 Node ID, Node coord. (meters) x,y,z                     3 0 0 3188.8
 51 BO   1 Node ID, Node coord. (meters) x,y,z                     4 0 0 -3188.8
 52 BO   1 Node ID, Node structual joint ID

 53 BO   2 Body ID number                                          2
 54 BO   2 Type (Rigid,Flexible,NASTRAN)                           R
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz                  .8543E12 1.5601E12
1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz                 0 0 0
 69 BO   2 Mass (kg)                                               12666300
 70 BO   2 Number of Nodes                                         5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                     1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                     2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                     3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                     4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                     5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                          3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                           R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz                  1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz                 0 0 0
 93 BO   3 Mass (kg)                                               2046600
 94 BO   3 Number of Nodes                                         2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                     1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                     2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                          4
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                           R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
110 BO   4 Conversion factors: Length,Mass,Force
111 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
112 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz                  1.7E12 1.7E12 3.4E12
113 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz                 0 0 0
114 BO   4 Mass (kg)                                               2046600
```

115	BO	4	Number of Nodes	2
116	BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117	BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118	BO	4	Node ID, Node structual joint ID	

HINGE

119	HI	1	Hinge ID number	1
120	HI	1	Inboard body ID, Outboard body ID	0 1
121	HI	1	"p" node ID, "q" node ID	0 2
122	HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123	HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124	HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125	HI	1	L2 unit vector in inboard body coord. x,y,z	
126	HI	1	L2 unit vector in outboard body coord. x,y,z	
127	HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128	HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129	HI	1	Initial rotation angles (deg)	-90. 0. -90.
130	HI	1	Initial rotation rates (deg/sec)	0 0 0
131	HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132	HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133	HI	1	Null torque angles (deg)	0 0 0
134	HI	1	Number of translation DOFs	3
135	HI	1	First translation unit vector g1	1 0 0
136	HI	1	Second translation unit vector g2	0 1 0
137	HI	1	Third translation unit vector g3	0 0 1
138	HI	1	Initial translation (meters)	0 0 42163421
139	HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140	HI	1	Translation stiffness (newtons/meters)	0 0 0
141	HI	1	Translation damping (newtons/meter/sec)	0 0 0
142	HI	1	Null force translations	0 0 0
143	HI	2	Hinge ID number	2
144	HI	2	Inboard body ID, Outboard body ID	1 2
145	HI	2	"p" node ID, "q" node ID	2 2
146	HI	2	Number of rotation DOFs	1
147	HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148	HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149	HI	2	L2 unit vector in inboard body coord. x,y,z	
150	HI	2	L2 unit vector in outboard body coord. x,y,z	
151	HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152	HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153	HI	2	Initial rotation angles (deg)	180. 0. 0.
154	HI	2	Initial rotation rates (deg/sec)	0.00417807
155	HI	2	Rotation stiffness (newton-meters/rad)	0
156	HI	2	Rotation damping (newton-meters/rad/sec)	0
157	HI	2	Null torque angles (deg)	0
158	HI	2	Number of translation DOFs	0
159	HI	2	First translation unit vector g1	1 0 0
160	HI	2	Second translation unit vector g2	0 1 0
161	HI	2	Third translation unit vector g3	0 0 1
162	HI	2	Initial translation (meters)	0 0 0
163	HI	2	Initial translation velocity (meters/sec)	
164	HI	2	Translation stiffness (newtons/meters)	
165	HI	2	Translation damping (newtons/meter/sec)	
166	HI	2	Null force translations	
167	HI	3	Hinge ID number	3
168	HI	3	Inboard body ID, Outboard body ID	1 3
169	HI	3	"p" node ID, "q" node ID	3 2
170	HI	3	Number of rotation DOFs	0
171	HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172	HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173	HI	3	L2 unit vector in inboard body coord. x,y,z	
174	HI	3	L2 unit vector in outboard body coord. x,y,z	
175	HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176	HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177	HI	3	Initial rotation angles (deg)	-90. 0. -146.75
178	HI	3	Initial rotation rates (deg/sec)	
179	HI	3	Rotation stiffness (newton-meters/rad)	

```
180 HI   3 Rotation damping (newton-meters/rad/sec)
181 HI   3 Null torque angles (deg)
182 HI   3 Number of translation DOFs                         0
183 HI   3 First translation unit vector   g1                 1 0 0
184 HI   3 Second translation unit vector  g2                 0 1 0
185 HI   3 Third translation unit vector   g3                 0 0 1
186 HI   3 Initial translation (meters)                       0 0 0
187 HI   3 Initial translation velocity (meters/sec)
188 HI   3 Translation stiffness (newtons/meters)
189 HI   3 Translation damping (newtons/meter/sec)
190 HI   3 Null force translations

191 HI   4 Hinge ID number                                    4
192 HI   4 Inboard body ID, Outboard body ID                  1 4
193 HI   4 "p" node ID, "q" node ID                           4 2
194 HI   4  Number of rotation DOFs                           0
195 HI   4 L1 unit vector in inboard body coord. x,y,z        0 0 1
196 HI   4 L1 unit vector in outboard body coord. x,y,z       0 0 1
197 HI   4 L2 unit vector in inboard body coord. x,y,z
198 HI   4 L2 unit vector in outboard body coord. x,y,z
199 HI   4 L3 unit vector in inboard body coord. x,y,z        0 1 0
200 HI   4 L3 unit vector in outboard body coord. x,y,z       0 1 0
201 HI   4 Initial rotation angles (deg)                      -90. 0. -56.75
202 HI   4 Initial rotation rates (deg/sec)
203 HI   4 Rotation stiffness (newton-meters/rad)
204 HI   4 Rotation damping (newton-meters/rad/sec)
205 HI   4 Null torque angles (deg)
206 HI   4 Number of translation DOFs                         0
207 HI   4 First translation unit vector   g1                 1 0 0
208 HI   4 Second translation unit vector  g2                 0 1 0
209 HI   4 Third translation unit vector   g3                 0 0 1
210 HI   4 Initial translation (meters)                       0 0 0
211 HI   4 Initial translation velocity (meters/sec)
212 HI   4 Translation stiffness (newtons/meters)
213 HI   4 Translation damping (newtons/meter/sec)
214 HI   4 Null force translations

           SENSOR

215 SE   1 Sensor ID number                                   1
216 SE   1 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ET
217 SE   1 Mounting point body ID, Mounting point node ID     2 2
218 SE   1 Second mounting point body ID, Second node ID
219 SE   1 Input axis unit vector (IA) x,y,z
220 SE   1 Mounting point Hinge index, Axis index
221 SE   1 First focal plane unit vector  (Fp1) x,y,z         0 0 -1
222 SE   1 Second focal plane unit vector (Fp2) x,y,z         0 1 0
223 SE   1 Sun/Star unit vector (Us) x,y,z
224 SE   1 Velocity Aberration Option (Y/N)
225 SE   1 Euler Angle Sequence (1-6)
226 SE   1 CMG ID number and Gimbal number
227 SE   1 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])   6378000 0 0 4.178074D-3

228 SE   2 Sensor ID number                                   2
229 SE   2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
230 SE   2 Mounting point body ID, Mounting point node ID     2 2
231 SE   2 Second mounting point body ID, Second node ID
232 SE   2 Input axis unit vector (IA) x,y,z
233 SE   2 Mounting point Hinge index, Axis index
234 SE   2 First focal plane unit vector  (Fp1) x,y,z         0 -1 0
235 SE   2 Second focal plane unit vector (Fp2) x,y,z         1 0 0
236 SE   2 Sun/Star unit vector (Us) x,y,z                    0 1 0
237 SE   2 Velocity Aberration Option (Y/N)                   N
238 SE   2 Euler Angle Sequence (1-6)
239 SE   2 CMG ID number and Gimbal number
240 SE   2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE   3 Sensor ID number                                   3
242 SE   3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
243 SE   3 Mounting point body ID, Mounting point node ID     1 2
```

```
244 SE   3 Second mounting point body ID, Second node ID
245 SE   3 Input axis unit vector (IA) x,y,z
246 SE   3 Mounting point Hinge index, Axis index
247 SE   3 First focal plane unit vector  (Fp1) x,y,z          -1 0 0
248 SE   3 Second focal plane unit vector (Fp2) x,y,z          0 0 1
249 SE   3 Sun/Star unit vector (Us) x,y,z                     0 0 0
250 SE   3 Velocity Aberration Option (Y/N)                    N
251 SE   3 Euler Angle Sequence (1-6)
252 SE   3 CMG ID number and Gimbal number
253 SE   3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE   4 Sensor ID number                                    4
255 SE   4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) A3
256 SE   4 Mounting point body ID, Mounting point node ID      1 2
257 SE   4 Second mounting point body ID, Second node ID
258 SE   4 Input axis unit vector (IA) x,y,z
259 SE   4 Mounting point Hinge index, Axis index
260 SE   4 First focal plane unit vector  (Fp1) x,y,z
261 SE   4 Second focal plane unit vector (Fp2) x,y,z
262 SE   4 Sun/Star unit vector (Us) x,y,z
263 SE   4 Velocity Aberration Option (Y/N)
264 SE   4 Euler Angle Sequence (1-6)
265 SE   4 CMG ID number and Gimbal number
266 SE   4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE   5 Sensor ID number                                    5
268 SE   5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) LV
269 SE   5 Mounting point body ID, Mounting point node ID      1 2
270 SE   5 Second mounting point body ID, Second node ID
271 SE   5 Input axis unit vector (IA) x,y,z
272 SE   5 Mounting point Hinge index, Axis index
273 SE   5 First focal plane unit vector  (Fp1) x,y,z
274 SE   5 Second focal plane unit vector (Fp2) x,y,z
275 SE   5 Sun/Star unit vector (Us) x,y,z
276 SE   5 Velocity Aberration Option (Y/N)
277 SE   5 Euler Angle Sequence (1-6)
278 SE   5 CMG ID number and Gimbal number
279 SE   5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE   6 Sensor ID number                                    6
281 SE   6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV L
282 SE   6 Mounting point body ID, Mounting point node ID      3 2
283 SE   6 Second mounting point body ID, Second node ID
284 SE   6 Input axis unit vector (IA) x,y,z                   1 0 0
285 SE   6 Mounting point Hinge index, Axis index
286 SE   6 First focal plane unit vector  (Fp1) x,y,z
287 SE   6 Second focal plane unit vector (Fp2) x,y,z
288 SE   6 Sun/Star unit vector (Us) x,y,z
289 SE   6 Velocity Aberration Option (Y/N)
290 SE   6 Euler Angle Sequence (1-6)
291 SE   6 CMG ID number and Gimbal number
292 SE   6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE   7 Sensor ID number                                    7
294 SE   7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV L
295 SE   7 Mounting point body ID, Mounting point node ID      4 2
296 SE   7 Second mounting point body ID, Second node ID
297 SE   7 Input axis unit vector (IA) x,y,z                   1 0 0
298 SE   7 Mounting point Hinge index, Axis index
299 SE   7 First focal plane unit vector  (Fp1) x,y,z
300 SE   7 Second focal plane unit vector (Fp2) x,y,z
301 SE   7 Sun/Star unit vector (Us) x,y,z
302 SE   7 Velocity Aberration Option (Y/N)
303 SE   7 Euler Angle Sequence (1-6)
304 SE   7 CMG ID number and Gimbal number
305 SE   7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

           ACTR

306 AC   1 Actuator ID number                                  1
```

```
307 AC   1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                     MO
308 AC   1 Actuator location; Node or Hinge (N or H)
309 AC   1 Mounting point body ID number, node ID number           2 2
310 AC   1 Second mounting point body ID, second node ID
311 AC   1 Output axis unit vector x,y,z                           0 1 0
312 AC   1 Mounting point Hinge index, Axis index
313 AC   1 Rotor spin axis unit vector x,y,z
314 AC   1 Initial rotor momentum, H
315 AC   1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
316 AC   1 Outer gimbal axis unit vector x,y,z
317 AC   1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
318 AC   1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
319 AC   1 Inner gimbal axis unit vector x,y,z
320 AC   1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
321 AC   1 Initial length and rate, y(to) and ydot(to)
322 AC   1 Constants; K1 or wo, n or zeta, Kg, Jm
323 AC   1 Non-linearities; TLim, Tco, Dz

324 AC   2 Actuator ID number                                      2
325 AC   2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                     MO
326 AC   2 Actuator location; Node or Hinge (N or H)
327 AC   2 Mounting point body ID number, node ID number           2 2
328 AC   2 Second mounting point body ID, second node ID
329 AC   2 Output axis unit vector x,y,z                           0 0 1
330 AC   2 Mounting point Hinge index, Axis index
331 AC   2 Rotor spin axis unit vector x,y,z
332 AC   2 Initial rotor momentum, H
333 AC   2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
334 AC   2 Outer gimbal axis unit vector x,y,z
335 AC   2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
336 AC   2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
337 AC   2 Inner gimbal axis unit vector x,y,z
338 AC   2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
339 AC   2 Initial length and rate, y(to) and ydot(to)
340 AC   2 Constants; K1 or wo, n or zeta, Kg, Jm
341 AC   2 Non-linearities; TLim, Tco, Dz

342 AC   3 Actuator ID number                                      3
343 AC   3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                     MO
344 AC   3 Actuator location; Node or Hinge (N or H)
345 AC   3 Mounting point body ID number, node ID number           2 2
346 AC   3 Second mounting point body ID, second node ID
347 AC   3 Output axis unit vector x,y,z                           1 0 0
348 AC   3 Mounting point Hinge index, Axis index
349 AC   3 Rotor spin axis unit vector x,y,z
350 AC   3 Initial rotor momentum, H
351 AC   3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
352 AC   3 Outer gimbal axis unit vector x,y,z
353 AC   3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
354 AC   3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
355 AC   3 Inner gimbal axis unit vector x,y,z
356 AC   3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
357 AC   3 Initial length and rate, y(to) and ydot(to)
358 AC   3 Constants; K1 or wo, n or zeta, Kg, Jm
359 AC   3 Non-linearities; TLim, Tco, Dz

360 AC   4 Actuator ID number                                      4
361 AC   4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                     T
362 AC   4 Actuator location; Node or Hinge (N or H)
363 AC   4 Mounting point body ID number, node ID number
364 AC   4 Second mounting point body ID, second node ID
365 AC   4 Output axis unit vector x,y,z
366 AC   4 Mounting point Hinge index, Axis index                  2 1
367 AC   4 Rotor spin axis unit vector x,y,z
368 AC   4 Initial rotor momentum, H
369 AC   4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
370 AC   4 Outer gimbal axis unit vector x,y,z
371 AC   4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
372 AC   4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
373 AC   4 Inner gimbal axis unit vector x,y,z
374 AC   4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
```

375 AC	4	Initial length and rate, y(to) and ydot(to)	
376 AC	4	Constants; K1 or wo, n or zeta, Kg, Jm	
377 AC	4	Non-linearities; TLim, Tco, Dz	
378 AC	5	Actuator ID number	5
379 AC	5	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)	J
380 AC	5	Actuator location; Node or Hinge (N or H)	
381 AC	5	Mounting point body ID number, node ID number	2 5
382 AC	5	Second mounting point body ID, second node ID	
383 AC	5	Output axis unit vector x,y,z	-1 0 0
384 AC	5	Mounting point Hinge index, Axis index	
385 AC	5	Rotor spin axis unit vector x,y,z	
386 AC	5	Initial rotor momentum, H	
387 AC	5	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
388 AC	5	Outer gimbal axis unit vector x,y,z	
389 AC	5	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
390 AC	5	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
391 AC	5	Inner gimbal axis unit vector x,y,z	
392 AC	5	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
393 AC	5	Initial length and rate, y(to) and ydot(to)	
394 AC	5	Constants; K1 or wo, n or zeta, Kg, Jm	
395 AC	5	Non-linearities; TLim, Tco, Dz	

CONTROLLER

396 CO	1	Controller ID number	1
397 CO	1	Controller type (CB,CM,DB,DM,UC,UD)	CM
398 CO	1	Sample time (sec)	
399 CO	1	Number of inputs, Number of outputs	4 4
400 CO	1	Number of states	
401 CO	1	Output No., Input type (I,S,T), Input ID, Gain	

INTERCONNECT

402 IN	1	Interconnect ID number	1
403 IN	1	Source type(S,C, or F),Source ID,Source row #	S 1 1
404 IN	1	Destination type(A or C),Dest ID,Dest row #	C 1 1
405 IN	1	Gain	4.41E13
406 IN	2	Interconnect ID number	2
407 IN	2	Source type(S,C, or F),Source ID,Source row #	C 1 1
408 IN	2	Destination type(A or C),Dest ID,Dest row #	A 1 1
409 IN	2	Gain	1
410 IN	3	Interconnect ID number	3
411 IN	3	Source type(S,C, or F),Source ID,Source row #	S 1 2
412 IN	3	Destination type(A or C),Dest ID,Dest row #	C 1 2
413 IN	3	Gain	1.67E12
414 IN	4	Interconnect ID number	4
415 IN	4	Source type(S,C, or F),Source ID,Source row #	C 1 2
416 IN	4	Destination type(A or C),Dest ID,Dest row #	A 2 1
417 IN	4	Gain	1
418 IN	5	Interconnect ID number	5
419 IN	5	Source type(S,C, or F),Source ID,Source row #	S 2 1
420 IN	5	Destination type(A or C),Dest ID,Dest row #	C 1 3
421 IN	5	Gain	4.31E13
422 IN	6	Interconnect ID number	6
423 IN	6	Source type(S,C, or F),Source ID,Source row #	C 1 3
424 IN	6	Destination type(A or C),Dest ID,Dest row #	A 3 1
425 IN	6	Gain	1
426 IN	7	Interconnect ID number	7
427 IN	7	Source type(S,C, or F),Source ID,Source row #	S 3 1
428 IN	7	Destination type(A or C),Dest ID,Dest row #	C 1 4
429 IN	7	Gain	6.7E8

```
430 IN   8 Interconnect ID number                               8
431 IN   8 Source type(S,C, or F),Source ID,Source row #        C 1 4
432 IN   8 Destination type(A or C),Dest ID,Dest row #          A 4 1
433 IN   8 Gain                                                 1

434 IN   9 Interconnect ID number                               9
435 IN   9 Source type(S,C, or F),Source ID,Source row #        S 3 3
436 IN   9 Destination type(A or C),Dest ID,Dest row #          A 5 1
437 IN   9 Gain                                                 7
```

A.2 Concept 2A Definitions and TREETOPS files

Sensor Definitions
Actuator Definitions
Interconnect Definitions
TREETOPS files:
Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

Table A.2.1 Sensor Definitions (Concept 2A and 2B)

Global Sensor Output No.	TREETOPS Sensor Designation	Local Sensor Output No.	Sensor Mount Loc.	Type	used	DOF
RP1	SE 1	1	B2-N2	Earth Target (ET) (LOS Along X^{B2})		Pitch (Y^{B2}) Error – Overall System
RP2	SE 1	2	B2-N2			Yaw (Z^{B2}) Error – Overall System
RP3	SE 2	1	B2-N2	Star Tracker (ST) (LOS Along Z^{B2})		Roll (X^{B2}) Error – Overall System
RP4	SE 2	2	B2-N2			Not used in control (Pitch (Y^{B2}) Error)
RP5	SE 2	3	B2-N2			Not used in control (Validity Flag on(1) off(0))
RP6	SE 3	1	B3-N2	LOS Sensor (L) (LOS Along $-Y^{I}$) (Negative Polar Axis) see .los file		Roll (X^{B3}) Error – Upper Clamshell
RP7	SE 3	2	B3-N2			Pitch (Y^{B3}) Error – Upper Clamshell
RP8	SE 3	3	B3-N2			Not used in control, Yaw (Z^{B3}) Error – Upper Clamshell
RP9	SE 3	4	B3-N2			Not used in control
RP10	SE 3	5	B3-N2			Not used in control
RP11	SE 3	6	B3-N2			Not used in control
RP12	SE 3	7	B3-N2			Not used in control
RP13	SE 4	1	B4-N2	LOS Sensor (L) (LOS Along $+Y^{I}$) (Positive Polar Axis) see .los file		Roll (X^{B4}) Error – Lower Clamshell
RP14	SE 4	2	B4-N2			Pitch (Y^{B4}) Error – Lower Clamshell
RP15	SE 4	3	B4-N2			Not used in control, Yaw (Z^{B4}) Error – Lower Clamshell
RP16	SE 4	4	B4-N2			Not used in control
RP 17	SE 4	5	B4-N2			Not used in control
RP 18	SE 4	6	B4-N2			Not used in control
RP 19	SE 4	7	B4-N2			Not used in control
RP 20	SE 5	1	B2-N5	Star Tracker (ST) (LOS Along $-X^{B2}$) (Towards Sun)		Not used in control (Yaw (Z^{B2}) Error
RP 21	SE 5	2	B2-N5			Not used in control (Pitch (Y^{B2}) Error)
RP 22	SE 5	3	B2-N5			Validity Flag on(1) off(0) Used for Rad Pres Disturb
RP 23	SE 6	1	B2-N2	3 Axis Accelerometer (A3) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B2})
RP 24	SE 6	2	B2-N2			Not used in control, For Output Only, ACCEL (Y^{B2})
RP 25	SE 6	3	B2-N2			Not used in control, For Output Only, ACCEL (Z^{B2})

Table A.2.2 Actuator Definitions (Concept 2A and 2B)

Global Actuator Input No.	TREETOPS Actuator Designation	Sensor Mount Loc.	Type	DOF
UP 1	AC 1	B2-N2	Moment Actuator (MO)*	Pitch (Y^{B2}) Ext. Torque – Overall System
UP 2	AC 2	B2-N2	Moment Actuator (MO)*	Yaw (Z^{B2}) Ext. Torque – Overall System
UP 3	AC 3	B2-N2	Moment Actuator (MO)*	Roll (X^{B2}) Ext. Torque – Overall System
UP 4	AC 4	B3-N2	Moment Actuator (MO)*	Roll (X^{B3}) Ext. Torque – Upper Clamshell
UP 5	AC 5	B3-N2	Moment Actuator (MO)*	Pitch (Y^{B3}) Ext. Torque – Upper Clamshell
UP 6	AC 6	B4-N2	Moment Actuator (MO)*	Roll (X^{B4}) Ext. Torque – Lower Clamshell
UP 7	AC 7	B4-N2	Moment Actuator (MO)*	Pitch (Y^{B4}) Ext. Torque – Lower Clamshell
UP 8	AC 8	B2-N5	Reaction Jet (J) Radiation Pressure Disturbance	$-X^{B2}$ Force at Central Body Transmitter

Notes:
* Moment Actuator (MO) in TREETOPS is an External Moment applied to a Body (Reacts against Space)
Used in Control

Table A.2.3: Interconnect Data and Significant Parameters for TREETOPS Continuous Matrix (CM) Controller (Concept 2A and 2B)

Interconnect Data						Significant Parameters in Continuous Matrix (CM) Controller in .lin file xdot = Ax + Bu y = Cx + Du			
Inter-connect	Description	S C C A	S No. C No. C No. A No.	S Out No. C In No. C Out No. A In No.	Gain N-m or N	Subset of A Matrix	Subset of B Matrix	Subset of C Matrix ω^2 $2\zeta\omega$	Subset of D Matrix
IC 1	Pitch (Y^{B2}) of Overall System	S	1	1	4.41E13	0. 1.	0	.000025 .007	0
		C	1	1					
IC 2		C	1	1	1.0	-1. -1.4	1		
		A	1	1					
IC 3	Yaw (Z^{B2}) of Overall System	S	1	2	1.67E12	0. 1.	0	.000025 .007	0
		C	1	2					
IC 4		C	1	2	1.0	-1. -1.4	1		
		A	2	1					
IC 5	Roll (X^{B2}) of Overall System	S	2	1	4.31E13	0. 1.	0	.000025 .007	0
		C	1	3					
IC 6		C	1	3	1.0	-1. -1.4	1		
		A	3	1					
IC 7	Roll (X^{B3}) of Upper Clamshell	S	3	1	1.7E12	0. 1.	0	.0001 .014	0
		C	1	4					
IC 8		C	1	4	1.0	-1. -1.4	1		
		A	4	1					
IC 9	Pitch (Y^{B3}) of Upper Clamshell	S	3	2	1.7E12	0. 1.	0	.0001 .014	0
		C	1	5					
IC 10		C	1	5	1.0	-1. -1.4	1		
		A	5	1					
IC 11	Roll (X^{B4}) of Lower Clamshell	S	4	1	1.7E12	0. 1.	0	.0001 .014	0
		C	1	6					
IC 12		C	1	6	1.0	-1. -1.4	1		
		A	6	1					
IC 13	Pitch (Y^{B4}) of Lower Clamshell	S	4	2	1.7E12	0. 1.	0	.0001 .014	0
		C	1	7					
IC 14		C	1	7	1.0	-1. -1.4	1		
		A	7	1					
IC 15	$-X^{B2}$ of Radiation Pres Disturb	S	5	3	7.0				
		A	8	1					

isc3_flex_sol.int (Concept 2A) Summer Solstice

```
TREETOPS REV 10P2  4/10/00

            SIM CONTROL

  1 SI   0 Title                                              ISC MODEL, THIRD VERSION
  2 SI   0 Simulation stop time                               100000
  3 SI   0 Plot data interval                                 20
  4 SI   0 Integration type (R,S,U, OR V)                     R
  5 SI   0 Step size (sec)                                    .1
  6 SI   0 Sandia ODE solver absolute and relative error
  7 SI   0 RK78 ODE solver absolute error and first step size
  8 SI   0 Linearization option  (L,Z or N)                   N
  9 SI   0 Restart option         (Y/N)                       N
 10 SI   0 Contact force computation option     (Y/N)         Y
 11 SI   0 Constraint force computation option  (Y/N)         N
 12 SI   0 Small angle speedup option (All,Bypass,First,Nth)  A
 13 SI   0 Mass matrix speedup option (All,Bypass,First,Nth)  A
 14 SI   0 Non-Linear  speedup option (All,Bypass,First,Nth)  A
 15 SI   0 Constraint  speedup option (All,Bypass,First,Nth)  A
 16 SI   0 Constraint stabilization option  (Y/N)             N
 17 SI   0 Stabilization epsilon


            GENGRAV

 18 GG   0 Gravity, earth sphere/nonsphere/user (S/N/U)?      N
 19 GG   1 Input gravity constants:  GME, ERAD, EMASS
 20 GG   1 Spherical or Nonspherical (S/N)?
 21 GG   1 Gravity Potential Harmonics J2,J3,J4
 22 GG   0 English (ft-slug-s) or metric (m-kg-s)    (E/M)?   M
 23 GG   0 Day, Month, Year,                                  21 6 2020
 24 GG   0 GMT @ sim time 0 (minutes past midnight,           0
 25 GG   0 Solar Pressure forces Y/N?                         Y
 26 GG   0 Input new data for aero model? (Y/N)               N
 27 GG   1   Solar flux F10 for aero model
 28 GG   1   Solar flux, 81 day average F10B
 29 GG   1   Geomagnetic index, GEAP


            BODY

 30 BO   1 Body ID number                                     1
 31 BO   1 Type (Rigid,Flexible,NASTRAN)                      F
 32 BO   1 Number of modes                                    24
 33 BO   1 Modal calculation option (0, 1 or 2)               2
 34 BO   1 Foreshortening option (Y/N)
 35 BO   1 Model reduction method (NO,MS,MC,CC,QM,CV)
 36 BO   1 NASTRAN data file FORTRAN unit number (40 - 60)
 37 BO   1 Number of augmented nodes (0 if none)
 38 BO   1 Damping matrix option (NS,CD,HL,SD)
 39 BO   1 Constant damping ratio
 40 BO   1 Low frequency, High frequency ratios
 41 BO   1 Mode ID number, damping ratio
 42 BO   1 Conversion factors: Length,Mass,Force
 43 BO   1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 44 BO   1 Moments of inertia (kg-m2) Ixx,Iyy,Izz             6.2852173E11 6.2852173E11
6.7057352E8
 45 BO   1 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0 0 0
 46 BO   1 Mass (kg)                                          1.6168633E5
 47 BO   1 Number of Nodes                                    4
 48 BO   1 Node ID, Node coord. (meters) x,y,z                1 0 0 0
 49 BO   1 Node ID, Node coord. (meters) x,y,z                2 0 0 0
 50 BO   1 Node ID, Node coord. (meters) x,y,z                3 0 0 3188.8
 51 BO   1 Node ID, Node coord. (meters) x,y,z                4 0 0 -3188.8
 52 BO   1 Node ID, Node structual joint ID
```

```
 53 BO   2 Body ID number                                          2
 54 BO   2 Type (Rigid,Flexible,NASTRAN)                           R
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz              .8543E12 1.5601E12
1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0 0 0
 69 BO   2 Mass (kg)                                             12666300
 70 BO   2 Number of Nodes                                       5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                   1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                   2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                   3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                   4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                   5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                          3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                           R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0 0 0
 93 BO   3 Mass (kg)                                             2046600
 94 BO   3 Number of Nodes                                       2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                   1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                   2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                          4
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                           R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
110 BO   4 Conversion factors: Length,Mass,Force
111 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
112 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1.7E12 1.7E12 3.4E12
113 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz              0 0 0
114 BO   4 Mass (kg)                                             2046600
115 BO   4 Number of Nodes                                       2
116 BO   4 Node ID, Node coord. (meters) x,y,z                   1 0 0 0
117 BO   4 Node ID, Node coord. (meters) x,y,z                   2 0 0 0
118 BO   4 Node ID, Node structual joint ID
```

HINGE

```
119 HI   1 Hinge ID number                                          1
120 HI   1 Inboard body ID, Outboard body ID                        0 1
121 HI   1 "p" node ID, "q" node ID                                 0 2
122 HI   1 Number of rotation DOFs, Rotation option (F or G)        3 F
123 HI   1 L1 unit vector in inboard body coord. x,y,z              1 0 0
124 HI   1 L1 unit vector in outboard body coord. x,y,z             1 0 0
125 HI   1 L2 unit vector in inboard body coord. x,y,z
126 HI   1 L2 unit vector in outboard body coord. x,y,z
127 HI   1 L3 unit vector in inboard body coord. x,y,z              0 0 1
128 HI   1 L3 unit vector in outboard body coord. x,y,z             0 0 1
129 HI   1 Initial rotation angles (deg)                            -90 0 90
130 HI   1 Initial rotation rates (deg/sec)                         0 0 0.00417807
131 HI   1 Rotation stiffness (newton-meters/rad)                   0 0 0
132 HI   1 Rotation damping (newton-meters/rad/sec)                 0 0 0
133 HI   1 Null torque angles (deg)                                 0 0 0
134 HI   1 Number of translation DOFs                               3
135 HI   1 First translation unit vector    g1                      1 0 0
136 HI   1 Second translation unit vector   g2                      0 1 0
137 HI   1 Third translation unit vector    g3                      0 0 1
138 HI   1 Initial translation (meters)                             0 0 42163421
139 HI   1 Initial translation velocity (meters/sec)                3074.681 0 0
140 HI   1 Translation stiffness (newtons/meters)                   0 0 0
141 HI   1 Translation damping (newtons/meter/sec)                  0 0 0
142 HI   1 Null force translations                                  0 0 0

143 HI   2 Hinge ID number                                          2
144 HI   2 Inboard body ID, Outboard body ID                        1 2
145 HI   2 "p" node ID, "q" node ID                                 2 2
146 HI   2  Number of rotation DOFs                                 0
147 HI   2 L1 unit vector in inboard body coord. x,y,z              0 0 1
148 HI   2 L1 unit vector in outboard body coord. x,y,z             0 0 1
149 HI   2 L2 unit vector in inboard body coord. x,y,z
150 HI   2 L2 unit vector in outboard body coord. x,y,z
151 HI   2 L3 unit vector in inboard body coord. x,y,z              1 0 0
152 HI   2 L3 unit vector in outboard body coord. x,y,z             1 0 0
153 HI   2 Initial rotation angles (deg)                            0 0 0
154 HI   2 Initial rotation rates (deg/sec)
155 HI   2 Rotation stiffness (newton-meters/rad)
156 HI   2 Rotation damping (newton-meters/rad/sec)
157 HI   2 Null torque angles (deg)
158 HI   2 Number of translation DOFs                               0
159 HI   2 First translation unit vector    g1                      1 0 0
160 HI   2 Second translation unit vector   g2                      0 1 0
161 HI   2 Third translation unit vector    g3                      0 0 1
162 HI   2 Initial translation (meters)                             0 0 0
163 HI   2 Initial translation velocity (meters/sec)
164 HI   2 Translation stiffness (newtons/meters)
165 HI   2 Translation damping (newtons/meter/sec)
166 HI   2 Null force translations

167 HI   3 Hinge ID number                                          3
168 HI   3 Inboard body ID, Outboard body ID                        1 3
169 HI   3 "p" node ID, "q" node ID                                 3 2
170 HI   3  Number of rotation DOFs                                 2
171 HI   3 L1 unit vector in inboard body coord. x,y,z              1 0 0
172 HI   3 L1 unit vector in outboard body coord. x,y,z             1 0 0
173 HI   3 L2 unit vector in inboard body coord. x,y,z              0 1 0
174 HI   3 L2 unit vector in outboard body coord. x,y,z             0 1 0
175 HI   3 L3 unit vector in inboard body coord. x,y,z
176 HI   3 L3 unit vector in outboard body coord. x,y,z
177 HI   3 Initial rotation angles (deg)                            123.25 0. 0.
178 HI   3 Initial rotation rates (deg/sec)                         0 0
179 HI   3 Rotation stiffness (newton-meters/rad)                   0 0
180 HI   3 Rotation damping (newton-meters/rad/sec)                 0 0
181 HI   3 Null torque angles (deg)                                 0 0
182 HI   3 Number of translation DOFs                               0
183 HI   3 First translation unit vector    g1                      1 0 0
184 HI   3 Second translation unit vector   g2                      0 1 0
```

```
185 HI   3 Third translation unit vector    g3                        0 0 1
186 HI   3 Initial translation (meters)                               0 0 0
187 HI   3 Initial translation velocity (meters/sec)
188 HI   3 Translation stiffness (newtons/meters)
189 HI   3 Translation damping (newtons/meter/sec)
190 HI   3 Null force translations

191 HI   4 Hinge ID number                                            4
192 HI   4 Inboard body ID, Outboard body ID                          1 4
193 HI   4 "p" node ID, "q" node ID                                   4 2
194 HI   4  Number of rotation DOFs                                   2
195 HI   4 L1 unit vector in inboard body coord. x,y,z                1 0 0
196 HI   4 L1 unit vector in outboard body coord. x,y,z               1 0 0
197 HI   4 L2 unit vector in inboard body coord. x,y,z                0 1 0
198 HI   4 L2 unit vector in outboard body coord. x,y,z               0 1 0
199 HI   4 L3 unit vector in inboard body coord. x,y,z
200 HI   4 L3 unit vector in outboard body coord. x,y,z
201 HI   4 Initial rotation angles (deg)                              33.25 0. 0.
202 HI   4 Initial rotation rates (deg/sec)                           0 0
203 HI   4 Rotation stiffness (newton-meters/rad)                     0 0
204 HI   4 Rotation damping (newton-meters/rad/sec)                   0 0
205 HI   4 Null torque angles (deg)                                   0 0
206 HI   4 Number of translation DOFs                                 0
207 HI   4 First translation unit vector    g1                        1 0 0
208 HI   4 Second translation unit vector   g2                        0 1 0
209 HI   4 Third translation unit vector    g3                        0 0 1
210 HI   4 Initial translation (meters)                               0 0 0
211 HI   4 Initial translation velocity (meters/sec)
212 HI   4 Translation stiffness (newtons/meters)
213 HI   4 Translation damping (newtons/meter/sec)
214 HI   4 Null force translations

           SENSOR

215 SE   1 Sensor ID number                                           1
216 SE   1 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)         ET
217 SE   1 Mounting point body ID, Mounting point node ID             2 2
218 SE   1 Second mounting point body ID, Second node ID
219 SE   1 Input axis unit vector (IA) x,y,z
220 SE   1 Mounting point Hinge index, Axis index
221 SE   1 First focal plane unit vector  (Fp1) x,y,z                 0 0 -1
222 SE   1 Second focal plane unit vector (Fp2) x,y,z                 0 1 0
223 SE   1 Sun/Star unit vector (Us) x,y,z
224 SE   1 Velocity Aberration Option (Y/N)
225 SE   1 Euler Angle Sequence (1-6)
226 SE   1 CMG ID number and Gimbal number
227 SE   1 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])           6378000 0 0 4.178074D-3

228 SE   2 Sensor ID number                                           2
229 SE   2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)         ST
230 SE   2 Mounting point body ID, Mounting point node ID             2 2
231 SE   2 Second mounting point body ID, Second node ID
232 SE   2 Input axis unit vector (IA) x,y,z
233 SE   2 Mounting point Hinge index, Axis index
234 SE   2 First focal plane unit vector  (Fp1) x,y,z                 0 -1 0
235 SE   2 Second focal plane unit vector (Fp2) x,y,z                 1 0 0
236 SE   2 Sun/Star unit vector (Us) x,y,z                            0 1 0
237 SE   2 Velocity Aberration Option (Y/N)                           N
238 SE   2 Euler Angle Sequence (1-6)
239 SE   2 CMG ID number and Gimbal number
240 SE   2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE   3 Sensor ID number                                           3
242 SE   3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)         L
243 SE   3 Mounting point body ID, Mounting point node ID             3 2
244 SE   3 Second mounting point body ID, Second node ID
245 SE   3 Input axis unit vector (IA) x,y,z                          1 2 3
246 SE   3 Mounting point Hinge index, Axis index
247 SE   3 First focal plane unit vector  (Fp1) x,y,z
248 SE   3 Second focal plane unit vector (Fp2) x,y,z
```

249	SE	3	Sun/Star unit vector (Us) x,y,z	
250	SE	3	Velocity Aberration Option (Y/N)	
251	SE	3	Euler Angle Sequence (1-6)	
252	SE	3	CMG ID number and Gimbal number	
253	SE	3	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254	SE	4	Sensor ID number	4
255	SE	4	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L
256	SE	4	Mounting point body ID, Mounting point node ID	4 2
257	SE	4	Second mounting point body ID, Second node ID	
258	SE	4	Input axis unit vector (IA) x,y,z	3 2 1
259	SE	4	Mounting point Hinge index, Axis index	
260	SE	4	First focal plane unit vector (Fp1) x,y,z	
261	SE	4	Second focal plane unit vector (Fp2) x,y,z	
262	SE	4	Sun/Star unit vector (Us) x,y,z	
263	SE	4	Velocity Aberration Option (Y/N)	
264	SE	4	Euler Angle Sequence (1-6)	
265	SE	4	CMG ID number and Gimbal number	
266	SE	4	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
267	SE	5	Sensor ID number	5
268	SE	5	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
269	SE	5	Mounting point body ID, Mounting point node ID	2 5
270	SE	5	Second mounting point body ID, Second node ID	
271	SE	5	Input axis unit vector (IA) x,y,z	
272	SE	5	Mounting point Hinge index, Axis index	
273	SE	5	First focal plane unit vector (Fp1) x,y,z	0 0 1
274	SE	5	Second focal plane unit vector (Fp2) x,y,z	0 -1 0
275	SE	5	Sun/Star unit vector (Us) x,y,z	0 0 0
276	SE	5	Velocity Aberration Option (Y/N)	N
277	SE	5	Euler Angle Sequence (1-6)	
278	SE	5	CMG ID number and Gimbal number	
279	SE	5	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
280	SE	6	Sensor ID number	6
281	SE	6	Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	A3
282	SE	6	Mounting point body ID, Mounting point node ID	2 2
283	SE	6	Second mounting point body ID, Second node ID	
284	SE	6	Input axis unit vector (IA) x,y,z	
285	SE	6	Mounting point Hinge index, Axis index	
286	SE	6	First focal plane unit vector (Fp1) x,y,z	
287	SE	6	Second focal plane unit vector (Fp2) x,y,z	
288	SE	6	Sun/Star unit vector (Us) x,y,z	
289	SE	6	Velocity Aberration Option (Y/N)	
290	SE	6	Euler Angle Sequence (1-6)	
291	SE	6	CMG ID number and Gimbal number	
292	SE	6	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
			ACTR	
293	AC	1	Actuator ID number	1
294	AC	1	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
295	AC	1	Actuator location; Node or Hinge (N or H)	
296	AC	1	Mounting point body ID number, node ID number	2 2
297	AC	1	Second mounting point body ID, second node ID	
298	AC	1	Output axis unit vector x,y,z	0 1 0
299	AC	1	Mounting point Hinge index, Axis index	
300	AC	1	Rotor spin axis unit vector x,y,z	
301	AC	1	Initial rotor momentum, H	
302	AC	1	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
303	AC	1	Outer gimbal axis unit vector x,y,z	
304	AC	1	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
305	AC	1	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
306	AC	1	Inner gimbal axis unit vector x,y,z	
307	AC	1	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
308	AC	1	Initial length and rate, y(to) and ydot(to)	
309	AC	1	Constants; K1 or wo, n or zeta, Kg, Jm	
310	AC	1	Non-linearities; TLim, Tco, Dz	
311	AC	2	Actuator ID number	2

```
312 AC    2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                        MO
313 AC    2 Actuator location; Node or Hinge (N or H)
314 AC    2 Mounting point body ID number, node ID number              2 2
315 AC    2 Second mounting point body ID, second node ID
316 AC    2 Output axis unit vector x,y,z                              0 0 1
317 AC    2 Mounting point Hinge index, Axis index
318 AC    2 Rotor spin axis unit vector x,y,z
319 AC    2 Initial rotor momentum, H
320 AC    2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
321 AC    2 Outer gimbal axis unit vector x,y,z
322 AC    2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
323 AC    2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
324 AC    2 Inner gimbal axis unit vector x,y,z
325 AC    2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
326 AC    2 Initial length and rate, y(to) and ydot(to)
327 AC    2 Constants; K1 or wo, n or zeta, Kg, Jm
328 AC    2 Non-linearities; TLim, Tco, Dz

329 AC    3 Actuator ID number                                         3
330 AC    3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                        MO
331 AC    3 Actuator location; Node or Hinge (N or H)
332 AC    3 Mounting point body ID number, node ID number              2 2
333 AC    3 Second mounting point body ID, second node ID
334 AC    3 Output axis unit vector x,y,z                              1 0 0
335 AC    3 Mounting point Hinge index, Axis index
336 AC    3 Rotor spin axis unit vector x,y,z
337 AC    3 Initial rotor momentum, H
338 AC    3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
339 AC    3 Outer gimbal axis unit vector x,y,z
340 AC    3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
341 AC    3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
342 AC    3 Inner gimbal axis unit vector x,y,z
343 AC    3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
344 AC    3 Initial length and rate, y(to) and ydot(to)
345 AC    3 Constants; K1 or wo, n or zeta, Kg, Jm
346 AC    3 Non-linearities; TLim, Tco, Dz

347 AC    4 Actuator ID number                                         4
348 AC    4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                        MO
349 AC    4 Actuator location; Node or Hinge (N or H)
350 AC    4 Mounting point body ID number, node ID number              3 2
351 AC    4 Second mounting point body ID, second node ID
352 AC    4 Output axis unit vector x,y,z                              1 0 0
353 AC    4 Mounting point Hinge index, Axis index
354 AC    4 Rotor spin axis unit vector x,y,z
355 AC    4 Initial rotor momentum, H
356 AC    4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
357 AC    4 Outer gimbal axis unit vector x,y,z
358 AC    4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
359 AC    4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
360 AC    4 Inner gimbal axis unit vector x,y,z
361 AC    4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
362 AC    4 Initial length and rate, y(to) and ydot(to)
363 AC    4 Constants; K1 or wo, n or zeta, Kg, Jm
364 AC    4 Non-linearities; TLim, Tco, Dz

365 AC    5 Actuator ID number                                         5
366 AC    5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                        MO
367 AC    5 Actuator location; Node or Hinge (N or H)
368 AC    5 Mounting point body ID number, node ID number              3 2
369 AC    5 Second mounting point body ID, second node ID
370 AC    5 Output axis unit vector x,y,z                              0 1 0
371 AC    5 Mounting point Hinge index, Axis index
372 AC    5 Rotor spin axis unit vector x,y,z
373 AC    5 Initial rotor momentum, H
374 AC    5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
375 AC    5 Outer gimbal axis unit vector x,y,z
376 AC    5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
377 AC    5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
378 AC    5 Inner gimbal axis unit vector x,y,z
379 AC    5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
```

```
380 AC   5 Initial length and rate, y(to) and ydot(to)
381 AC   5 Constants; K1 or wo, n or zeta, Kg, Jm
382 AC   5 Non-linearities; TLim, Tco, Dz

383 AC   6 Actuator ID number                                  6
384 AC   6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
385 AC   6 Actuator location; Node or Hinge (N or H)
386 AC   6 Mounting point body ID number, node ID number       4 2
387 AC   6 Second mounting point body ID, second node ID
388 AC   6 Output axis unit vector x,y,z                       1 0 0
389 AC   6 Mounting point Hinge index, Axis index
390 AC   6 Rotor spin axis unit vector x,y,z
391 AC   6 Initial rotor momentum, H
392 AC   6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
393 AC   6 Outer gimbal axis unit vector x,y,z
394 AC   6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
395 AC   6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
396 AC   6 Inner gimbal axis unit vector x,y,z
397 AC   6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
398 AC   6 Initial length and rate, y(to) and ydot(to)
399 AC   6 Constants; K1 or wo, n or zeta, Kg, Jm
400 AC   6 Non-linearities; TLim, Tco, Dz

401 AC   7 Actuator ID number                                  7
402 AC   7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
403 AC   7 Actuator location; Node or Hinge (N or H)
404 AC   7 Mounting point body ID number, node ID number       4 2
405 AC   7 Second mounting point body ID, second node ID
406 AC   7 Output axis unit vector x,y,z                       0 1 0
407 AC   7 Mounting point Hinge index, Axis index
408 AC   7 Rotor spin axis unit vector x,y,z
409 AC   7 Initial rotor momentum, H
410 AC   7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
411 AC   7 Outer gimbal axis unit vector x,y,z
412 AC   7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
413 AC   7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
414 AC   7 Inner gimbal axis unit vector x,y,z
415 AC   7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
416 AC   7 Initial length and rate, y(to) and ydot(to)
417 AC   7 Constants; K1 or wo, n or zeta, Kg, Jm
418 AC   7 Non-linearities; TLim, Tco, Dz

419 AC   8 Actuator ID number                                  8
420 AC   8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 J
421 AC   8 Actuator location; Node or Hinge (N or H)
422 AC   8 Mounting point body ID number, node ID number       2 5
423 AC   8 Second mounting point body ID, second node ID
424 AC   8 Output axis unit vector x,y,z                       -1 0 0
425 AC   8 Mounting point Hinge index, Axis index
426 AC   8 Rotor spin axis unit vector x,y,z
427 AC   8 Initial rotor momentum, H
428 AC   8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
429 AC   8 Outer gimbal axis unit vector x,y,z
430 AC   8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
431 AC   8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
432 AC   8 Inner gimbal axis unit vector x,y,z
433 AC   8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
434 AC   8 Initial length and rate, y(to) and ydot(to)
435 AC   8 Constants; K1 or wo, n or zeta, Kg, Jm
436 AC   8 Non-linearities; TLim, Tco, Dz

         CONTROLLER

437 CO   1 Controller ID number                                1
438 CO   1 Controller type (CB,CM,DB,DM,UC,UD)                 CM
439 CO   1 Sample time (sec)
440 CO   1 Number of inputs, Number of outputs                 7 7
441 CO   1 Number of states
442 CO   1 Output No., Input type (I,S,T), Input ID, Gain
```

INTERCONNECT

443	IN	1	Interconnect ID number	1
444	IN	1	Source type(S,C, or F),Source ID,Source row #	S 1 1
445	IN	1	Destination type(A or C),Dest ID,Dest row #	C 1 1
446	IN	1	Gain	4.41E13
447	IN	2	Interconnect ID number	2
448	IN	2	Source type(S,C, or F),Source ID,Source row #	C 1 1
449	IN	2	Destination type(A or C),Dest ID,Dest row #	A 1 1
450	IN	2	Gain	1.
451	IN	3	Interconnect ID number	3
452	IN	3	Source type(S,C, or F),Source ID,Source row #	S 1 2
453	IN	3	Destination type(A or C),Dest ID,Dest row #	C 1 2
454	IN	3	Gain	1.67E12
455	IN	4	Interconnect ID number	4
456	IN	4	Source type(S,C, or F),Source ID,Source row #	C 1 2
457	IN	4	Destination type(A or C),Dest ID,Dest row #	A 2 1
458	IN	4	Gain	1
459	IN	5	Interconnect ID number	5
460	IN	5	Source type(S,C, or F),Source ID,Source row #	S 2 1
461	IN	5	Destination type(A or C),Dest ID,Dest row #	C 1 3
462	IN	5	Gain	4.31E13
463	IN	6	Interconnect ID number	6
464	IN	6	Source type(S,C, or F),Source ID,Source row #	C 1 3
465	IN	6	Destination type(A or C),Dest ID,Dest row #	A 3 1
466	IN	6	Gain	1
467	IN	7	Interconnect ID number	7
468	IN	7	Source type(S,C, or F),Source ID,Source row #	S 3 1
469	IN	7	Destination type(A or C),Dest ID,Dest row #	C 1 4
470	IN	7	Gain	1.7E12
471	IN	8	Interconnect ID number	8
472	IN	8	Source type(S,C, or F),Source ID,Source row #	C 1 4
473	IN	8	Destination type(A or C),Dest ID,Dest row #	A 4 1
474	IN	8	Gain	1
475	IN	9	Interconnect ID number	9
476	IN	9	Source type(S,C, or F),Source ID,Source row #	S 3 2
477	IN	9	Destination type(A or C),Dest ID,Dest row #	C 1 5
478	IN	9	Gain	1.7E12
479	IN	10	Interconnect ID number	10
480	IN	10	Source type(S,C, or F),Source ID,Source row #	C 1 5
481	IN	10	Destination type(A or C),Dest ID,Dest row #	A 5 1
482	IN	10	Gain	1
483	IN	11	Interconnect ID number	11
484	IN	11	Source type(S,C, or F),Source ID,Source row #	S 4 1
485	IN	11	Destination type(A or C),Dest ID,Dest row #	C 1 6
486	IN	11	Gain	1.7E12
487	IN	12	Interconnect ID number	12
488	IN	12	Source type(S,C, or F),Source ID,Source row #	C 1 6
489	IN	12	Destination type(A or C),Dest ID,Dest row #	A 6 1
490	IN	12	Gain	1
491	IN	13	Interconnect ID number	13
492	IN	13	Source type(S,C, or F),Source ID,Source row #	S 4 2
493	IN	13	Destination type(A or C),Dest ID,Dest row #	C 1 7
494	IN	13	Gain	1.7E12
495	IN	14	Interconnect ID number	14
496	IN	14	Source type(S,C, or F),Source ID,Source row #	C 1 7
497	IN	14	Destination type(A or C),Dest ID,Dest row #	A 7 1

```
498 IN  14 Gain                                                     1

499 IN  15 Interconnect ID number                                   15
500 IN  15 Source type(S,C, or F),Source ID,Source row #            S 5 3
501 IN  15 Destination type(A or C),Dest ID,Dest row #              A 8 1
502 IN  15 Gain                                                     7.0
```

isc3_flex_sol.lin (Concept 2A) Summer Solstice

```
* Controller for integrated symmetrical concentrator
system CONT1 14,7,7,0,0,0.0
*A
0 1 0 0 0 0 0 0 0 0 0 0 0 0
-1 -1.4 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 -1 -1.4 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 -1 -1.4 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 -1 -1.4 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 -1 -1.4 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 0 0 0 -1 -1.4 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0 0 0 0 0 -1 -1.4
*B
0 0 0 0 0 0 0
1 0 0 0 0 0 0
0 0 0 0 0 0 0
0 1 0 0 0 0 0
0 0 0 0 0 0 0
0 0 1 0 0 0 0
0 0 0 0 0 0 0
0 0 0 1 0 0 0
0 0 0 0 0 0 0
0 0 0 0 1 0 0
0 0 0 0 0 0 0
0 0 0 0 0 1 0
0 0 0 0 0 0 0
0 0 0 0 0 0 1

*C
.000025 .007  0 0 0 0 0 0 0 0 0 0 0 0
0 0 .000025 .007 0 0 0 0 0 0 0 0 0 0
0 0 0 0 .000025 .007 0 0 0 0 0 0 0 0
0 0 0 0 0 0 .0001 .014  0 0 0 0 0 0
0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0
0 0 0 0 0 0 0 0 0 0 .0001 .014  0 0
0 0 0 0 0 0 0 0 0 0 0 0 .0001 .014
*D
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
*H
*M
```

los.dat (Concept 2A) Summer Solstice

```
3,               ! Sensor number of 1st FGS (clamshell) sensor
0.d0,0.d0,0.d0,        ! Defaults to sun as a target for zero input vector
0.d0, -1.d0,0.d0,      ! Target star along negative polar axis
0.d0,-1.d0,0.d0,       ! Focal plane vector 1
1.d0,0.d0,0.d0,        ! Focal plane vector 2
1.d0,0.d0,0.d0,        ! Focal plane vector 3

 4,              ! Sensor number of 2nd FGS (clamshell) sensor
0.d0,0.d0,0.d0,        ! Defaults to sun as a target for zero input vector
0.d0, 1.d0,0.d0,       ! Target star along positive polar axis
0.d0,-1.d0,0.d0,       ! Focal plane vector 1
1.d0,0.d0,0.d0,        ! Focal plane vector 2
-1.d0,0.d0,0.d0,       ! Focal plane vector 3
```

solar_pressure.dat (Concept 2A) Summer Solstice

```
22, 'm',        ! number of panels, units English or Metric ***Updated 11/15/00***
1,2,638000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,-7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,-7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0, 0.1736d0,0.d0,0.9848d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0, -0.1736d0,1.d0,-0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0, 0.1736d0,0.d0,-0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0, -0.1736d0,-1.d0,0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0, 1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,     ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,      ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,     ! body, node, area, reflectivity factor,outward normal,centroid
```

isc3_flex_sol.flx (Concept 2A) Summer Solstice (An Excerpt)

```
flag, revision number
XXXXXX         1
  body id
      1
  modes, nodes, modal options
      24        4        0        0        0        0        0        0
       0        0        0        0        0        0        0        0
       0        0        0        0        0        0        0        0
       0        0        0        0        0        0        0        0
  phi_t for node #             2
  .31310941E-02 -.16357954E-03  .19158607E-08  .68659216E-04  .31346273E-02
  .14949358E-08 -.33409338E-09 -.17910070E-08 -.62130721E-04  .10048928E-08
  .74260327E-10 -.81693812E-09  .66744219E-10 -.57300403E-09  .56292416E-10
 -.31109642E-09  .51999889E-08  .41569313E-10  .36697769E-02  .69502051E-03
  .85567197E-10 -.10557893E-02  .35826871E-02  .65924560E-10  .61553749E-10
  .11085623E-08 -.67301328E-05  .49549244E-10 -.49437998E-08 -.60865848E-11
  .10484816E-08  .39239830E-10 -.17858973E-09  .46440350E-10  .23145265E-09
  .76239104E-11 -.98486197E-09 -.52382674E-09  .30708566E-12  .12143532E-10
 -.10722701E-09  .94529479E-03  .17735129E-08  .15323995E-09  .13868812E-12
 -.13390485E-02 -.55272105E-04 -.82202021E-12  .55317399E-04 -.13390483E-02
  .27552836E-11  .29149021E-10 -.27567962E-12 -.44865972E-10  .48584658E-11
  .10595799E-10 -.31919479E-08 -.19937738E-10  .14255509E-09 -.23770452E-02
 -.45933446E-03 -.19673179E-04  .63985161E-12 -.19675549E-04  .45933391E-03
 -.74265281E-12 -.34874105E-11 -.12587102E-11  .59687765E-09 -.12099360E-11
 -.69004494E-11  .19524343E-08
  phi_t prime for node #             2
  .17177767E-11 -.22808543E-11 -.45683561E-10  .19817016E-10  .56718933E-12
  .31514104E-09  .17463000E-11 -.27057756E-13 -.60467460E-12  .11400599E-06
 -.42543750E-05 -.11919737E-10  .42546793E-05  .10153760E-06 -.34352434E-10
  .41859459E-11 -.37080794E-11  .59234151E-04  .45504345E-11 -.70844966E-12
  .15588470E-10  .13593377E-10  .68741697E-12  .87795145E-10 -.28497036E-11
  .31909564E-13 -.69421743E-15  .38765922E-11 -.41335440E-11 -.44983453E-04
  .22473012E-05 -.13022411E-04  .41075666E-11 -.13101519E-04 -.17274113E-05
 -.98017672E-11 -.14778531E-12 -.42275125E-13 -.96071643E-06 -.25440820E-11
  .54200130E-11  .41425181E-12 -.51084189E-13  .98880082E-15  .14899414E-06
 -.49351318E-14  .15066380E-14 -.42969795E-10 -.54223125E-14  .27635772E-15
 -.79851673E-11  .23444071E-06 -.40722409E-05 -.13017710E-13  .40722809E-05
  .23382333E-06  .64327760E-12 -.80030821E-11  .19070818E-11  .27557384E-13
  .67193209E-14  .15459451E-13  .15489036E-10  .28188639E-13  .15021236E-15
  .22611633E-11 -.61243211E-07  .17482812E-05  .30019490E-13 -.17482739E-05
 -.61449314E-07 -.27684414E-12
  phi_t for node #             3
 -.42404714E-02  .49480955E-03  .19835813E-08 -.36612814E-03 -.42534660E-02
  .96750031E-09  .42209027E-09  .30963712E-08  .40516924E-04  .38549281E-02
 -.52714285E-03 -.87737477E-09  .53843743E-03  .38533672E-02 -.10363838E-09
  .38623427E-08 -.71743451E-08  .24131659E-03  .31427071E-02 -.10270931E-03
  .15812594E-09 -.20969267E-03  .31373775E-02  .44642715E-09  .28790083E-09
  .88009461E-09  .18408168E-03 -.17813513E-08 -.27431844E-08  .15957166E-04
 -.19242852E-02  .34087019E-03 -.22330623E-09  .41716037E-03  .19091971E-02
 -.71605887E-10  .95016675E-09 -.81490514E-09  .32861442E-02 -.18116747E-08
  .55541036E-09  .79551900E-03 -.41608643E-08 -.26069981E-09  .94036451E-02
  .21682867E-02 -.12127210E-02  .85710915E-08  .12126479E-02  .21683282E-02
 -.39141685E-08  .18971552E-02 -.12009168E-02  .43705940E-08  .12012029E-02
  .18969745E-02  .16937062E-07 -.67726532E-08 -.66549206E-08  .11440634E-01
  .49982895E-02 -.24804966E-02  .39527267E-09 -.24804686E-02 -.49983050E-02
 -.34622476E-08 -.50056020E-02  .25440974E-02 -.23331468E-08 -.25435047E-02
 -.50059046E-02 -.85708461E-08
  phi_t prime for node #             3
 -.50525028E-06 -.31564387E-05 -.80521842E-10  .31702786E-05 -.40940183E-06
  .57389171E-09 -.26678138E-11  .65900274E-12 -.58046889E-04  .10244708E-05
  .47674564E-05  .15531760E-10 -.47644389E-05  .10384376E-05  .44257276E-10
  .11200572E-10  .49389619E-11 -.61429724E-04  .68382965E-06  .54576833E-05
 -.20073106E-10 -.54985919E-05  .13880871E-06 -.11950858E-09 -.12906028E-11
  .35486701E-12 -.77274292E-04  .61171041E-11 -.56114520E-11 -.65377923E-04
 -.17172111E-05 -.54788611E-05  .24079039E-11 -.54062017E-05  .19338345E-05
  .41797610E-11  .67570000E-11  .20000043E-10  .51675836E-06 -.99163146E-11
 -.24536147E-10  .16113741E-05 -.24387637E-10 -.45291231E-10  .14474359E-04
  .40550997E-04  .55846277E-04 -.22605263E-10 -.55847708E-04  .40549096E-04
```

```
-.12064872E-11  .40806300E-04  .51925447E-04 -.22326921E-10 -.51919351E-04
 .40814113E-04  .35521932E-10  .15828591E-09 -.16771401E-09  .21209458E-04
 .16987298E-03  .27619447E-03  .11975439E-09  .27619558E-03 -.16987148E-03
-.57982074E-10 -.17376694E-03 -.27781790E-03 -.11765510E-09  .27783862E-03
-.17373409E-03 -.70075300E-10
 phi_t for node #        4
-.42404802E-02  .49480360E-03  .18585028E-08 -.36612933E-03 -.42535396E-02
 .21036956E-08  .39723035E-09 -.14786269E-09  .40516905E-04 -.38549306E-02
 .52714303E-03 -.77214743E-09 -.53843745E-03 -.38533660E-02  .20798890E-09
-.73886299E-08 -.15978809E-07 -.24131650E-03  .31427093E-02 -.10270436E-03
 .13801450E-10 -.20968938E-03  .31373931E-02 -.39914612E-09  .41931685E-11
 .99616139E-10  .18408168E-03  .35438059E-09 -.17390277E-08 -.15957178E-04
 .19242857E-02 -.34087031E-03 -.23866856E-09 -.41716036E-03 -.19091972E-02
-.19395891E-10  .94356214E-09 -.84924469E-09 -.32861442E-02  .18078300E-08
-.56604075E-09  .79551900E-03 -.41738415E-08 -.28114281E-09 -.94036451E-02
 .21682868E-02 -.12127209E-02 -.85410786E-08  .12126480E-02  .21683284E-02
 .38256346E-08 -.18971552E-02  .12009169E-02  .43704936E-08 -.12012030E-02
-.18969746E-02  .17005110E-07  .67789071E-08  .66775796E-08  .11440634E-01
 .49982897E-02 -.24804968E-02 -.39492666E-09 -.24804688E-02 -.49983053E-02
 .34827434E-08  .50056020E-02 -.25440973E-02 -.23324836E-08  .25435049E-02
 .50059050E-02 -.85841247E-08
 phi_t prime for node #        4
 .50524725E-06  .31564441E-05 -.82070494E-10 -.31703213E-05  .40940604E-06
 .62154334E-09  .34011412E-12 -.27858908E-12  .58046878E-04  .10244712E-05
 .47674599E-05  .13355611E-10 -.47644372E-05  .10384375E-05  .44054122E-10
-.22077045E-10  .11247290E-10 -.61429722E-04 -.68382100E-06 -.54576879E-05
-.24245181E-10  .54986198E-05 -.13881681E-06 -.15347238E-09  .50958361E-12
-.41824742E-12  .77274292E-04 -.42833617E-11  .34928804E-12 -.65377921E-04
-.17172117E-05 -.54788625E-05  .15891701E-11 -.54062019E-05  .19338345E-05
-.90655410E-11 -.71395520E-11 -.19852937E-10  .51675837E-06 -.10061491E-10
-.24464605E-10 -.16113739E-05  .23986931E-10  .45635598E-10  .14474359E-04
-.40550995E-04 -.55846279E-04 -.22604313E-10  .55847713E-04 -.40549100E-04
-.14851140E-11  .40806300E-04  .51925447E-04  .22357522E-10 -.51919354E-04
 .40814116E-04 -.35835384E-10  .15906312E-09 -.16795738E-09 -.21209458E-04
-.16987299E-03 -.27619447E-03  .11979215E-09 -.27619560E-03  .16987149E-03
-.57726900E-10 -.17376694E-03 -.27781789E-03  .11764036E-09  .27783864E-03
-.17373411E-03  .70185849E-10
 mass matrix
 .10000000E+01 -.30291562E-01 -.76876291E-07  .73800796E-06  .32867117E-06
 .13158549E-06 -.92633251E-08 -.17952422E-07  .62673968E-08 -.19995321E-07
 .20953681E-06 -.61379992E-07  .12006683E-09 -.11753664E-09  .88805322E-10
 .18582751E-09  .93589593E-10  .34601899E-08  .12520782E-08  .51220876E-10
-.26895388E-10 -.46932083E-10 -.51456416E-09 -.16699282E-09 -.30291562E-01
 .10000000E+01  .26989693E-07  .24701420E-07  .34123181E-05  .19569915E-07
 .18126030E-07 -.22083024E-07 -.30895835E-08 -.63797417E-09  .13846796E-06
-.91584230E-06  .28463240E-09 -.92291186E-09  .13196997E-09 -.83498605E-10
-.23061102E-09  .37066771E-09  .14015707E-07  .71524564E-09 -.97352491E-12
-.79781628E-10 -.28504651E-10 -.24628018E-08 -.76876291E-07  .26989693E-07
 .10000000E+01 -.12820039E-07  .23873133E-06  .46502856E-07  .48615925E-08
-.31587180E-08 -.94997621E-10 -.56075172E-08  .49113872E-08 -.51914907E-07
-.57636964E-11  .45511296E-10  .45041193E-11 -.28608624E-10  .92163317E-11
-.16290986E-10  .76859350E-09 -.31071312E-10 -.47158520E-11 -.13956592E-11
 .40931813E-11 -.13308932E-09  .73800796E-06  .24701420E-07 -.12820039E-07
 .10000000E+01  .29302137E-02  .10572523E-05 -.24430484E-06  .68476034E-07
 .92720426E-09 -.64534578E-07  .16242822E-07  .86600013E-08  .72440444E-09
 .16245107E-08 -.11209088E-09  .55930229E-10 -.44166054E-09 -.10256621E-08
-.50144862E-09 -.15880740E-08  .25789654E-09 -.98514653E-10 -.37720327E-09
 .27460623E-09  .32867117E-06  .34123181E-05  .23873133E-06  .29302137E-02
 .10000000E+01  .71189247E-06 -.53815780E-06 -.15566832E-05  .83251907E-07
-.45009419E-07 -.44807150E-07  .17705875E-07 -.16602525E-08 -.43070508E-08
-.20692528E-09  .20019442E-08  .57241159E-08 -.72556163E-09  .93151063E-09
 .18206492E-08 -.13561118E-09 -.12897281E-08 -.25829052E-10  .16156569E-09
 .13158549E-06  .19569915E-07  .46502856E-07  .10572523E-05  .71189247E-06
 .10000000E+01 -.83160269E-07  .24349543E-07  .11233865E-07  .10028917E-06
-.12313102E-06  .70134651E-07 -.13207290E-08  .28173844E-08 -.11660397E-08
 .22882173E-09 -.30171128E-09 -.14728997E-08 -.13109908E-08  .32317686E-09
 .12105915E-10 -.55168990E-10  .27914248E-09  .14656790E-09 -.92633250E-08
 .18126030E-07  .48615925E-08 -.24430484E-06 -.53815780E-06 -.83160269E-07
 .10000000E+01 -.99242756E-01  .22394316E-07 -.39958298E-07  .32234509E-06
-.50160922E-06  .23636843E-09 -.21910738E-09  .14348669E-09  .15847338E-09
 .74774558E-10  .32733302E-08  .57239272E-08  .10031900E-09 -.36640911E-10
```

-.81560611E-10	-.45187655E-09	-.93057423E-09	-.17952422E-07	-.22083024E-07
-.31587180E-08	.68476034E-07	-.15566832E-05	.24349543E-07	-.99242756E-01
.10000000E+01	-.20074054E-07	.16458235E-07	.15485050E-06	-.15630944E-05
.29386609E-09	-.10163269E-08	.11846928E-09	-.20501990E-09	-.41770205E-09
-.56246450E-09	.16797163E-07	.78252621E-09	.33675344E-11	-.57812240E-10
.11108613E-09	-.29422473E-08	.62673968E-08	-.30895835E-08	-.94997760E-10
.92720426E-09	.83251907E-07	.11233865E-07	.22394316E-07	-.20074054E-07
.10000000E+01	.12712850E-07	-.23627686E-07	.15204590E-06	.96068819E-11
-.66710239E-10	-.23527708E-12	.57865057E-10	-.34048646E-10	-.56274547E-10
-.13467924E-08	.57321148E-10	.72512622E-11	.43261077E-11	.42475879E-11
.23009307E-09	-.19995321E-07	-.63797417E-09	-.56075174E-08	-.64534578E-07
-.45009419E-07	.10028917E-06	-.39958298E-07	.16458235E-07	.12712850E-07
.10000000E+01	.34013758E-06	-.19456390E-06	.12276100E-08	-.23143374E-08
.90995226E-09	-.20703316E-09	.26711414E-09	.17484259E-08	.14384415E-08
-.22089987E-09	-.12869248E-10	.38339013E-10	-.31448481E-09	-.18544250E-09
.20953681E-06	.13846796E-06	.49113872E-08	.16242822E-07	-.44807150E-07
-.12313102E-06	.32234509E-06	.15485050E-06	-.23627686E-07	.34013758E-06
.10000000E+01	-.39786267E-01	.17049808E-08	.38885439E-08	-.46588188E-09
.12616452E-08	.13318808E-08	-.42894021E-08	.74108288E-09	-.45855306E-08
.76304756E-09	-.90324773E-09	-.10747486E-08	.61285555E-09	-.61379992E-07
-.91584230E-06	-.51914907E-07	.86600013E-08	.17705875E-07	.70134651E-07
-.50160922E-06	-.15630944E-05	.15204590E-06	-.19456390E-06	-.39786267E-01
.10000000E+01	.62505978E-08	.15167020E-07	.64225500E-09	-.64493380E-08
-.19359751E-07	.14627884E-08	-.39742767E-08	-.61200326E-08	.51696455E-09
.41021165E-08	.38755886E-10	-.28087086E-09	.12006683E-09	.28463240E-09
-.57637523E-11	.72440444E-09	-.16602525E-08	-.13207290E-08	.23636843E-09
.29386609E-09	.96069199E-11	.12276100E-08	.17049808E-08	.62505978E-08
.10000000E+01	.73552646E-10	.38814802E-10	.36872491E-10	.72462767E-10
-.30908303E-09	.78347194E-09	-.80736378E-10	.38873326E-11	-.52248843E-11
.43195040E-10	-.10247581E-09	-.11753664E-09	-.92291186E-09	.45511310E-10
.16245107E-08	-.43070508E-08	.28173844E-08	-.21910738E-09	-.10163269E-08
-.66710219E-10	-.23143374E-08	.38885439E-08	.15167020E-07	.73552316E-10
.10000000E+01	-.15617476E-09	-.61749360E-11	-.26777146E-09	-.10599770E-08
.29161646E-08	-.20094998E-09	.18211917E-10	.26472063E-10	.16702574E-09
-.34247066E-09	.88805322E-10	.13196997E-09	.45041462E-11	-.11209088E-09
-.20692528E-09	-.11660397E-08	.14348669E-09	.11846928E-09	-.23525973E-12
.90995225E-09	-.46588188E-09	.64225500E-09	.38814889E-10	-.15617482E-09
.10000000E+01	.12187317E-09	.15001747E-09	.24640744E-09	.42025294E-09
-.18289440E-09	.56313574E-11	-.72942198E-11	-.17559408E-10	-.32344202E-10
.18582743E-09	-.83498576E-10	-.28608624E-10	.55930264E-10	.20019442E-08
.22882173E-09	.15847327E-09	-.20501985E-09	.57865057E-10	-.20703316E-09
.12616453E-08	-.64493380E-08	.36872491E-10	-.61749360E-11	.12187317E-09
.10000000E+01	-.32661816E-04	-.43944057E-08	-.24952357E-07	.81538381E-10
.34212335E-10	.38356819E-10	.24612814E-10	.46331501E-09	.93589566E-10
-.23061114E-09	.92163317E-11	-.44166048E-09	.57241158E-08	-.30171128E-09
.74774490E-10	-.41770205E-09	-.34048646E-10	.26711414E-09	.13318808E-08
-.19359751E-07	.72462767E-10	-.26777146E-09	.15001747E-09	-.32661816E-04
.10000000E+01	.42300905E-08	-.73197671E-07	-.10441846E-08	-.14602376E-11
.73313057E-10	-.10191802E-09	.14986050E-08	.34601900E-08	.37066776E-09
-.16290986E-10	-.10256622E-08	-.72556165E-09	-.14728997E-08	.32733303E-08
-.56246452E-09	-.56274547E-10	.17484259E-08	-.42894022E-08	.14627883E-08
-.30908303E-09	-.10599770E-08	.24640744E-09	-.43944057E-08	.42300905E-08
.10000000E+01	.15221368E-03	-.86338705E-08	.45921228E-09	-.20521056E-09
-.89116174E-09	.26024348E-09	.12520782E-08	.14015707E-07	.76859350E-09
-.50144861E-09	.93151061E-09	-.13109908E-08	.57239273E-08	.16797163E-07
-.13467924E-08	.14384415E-08	.74108288E-09	-.39742767E-08	.78347194E-09
.29161646E-08	.42025294E-09	-.24952357E-07	-.73197671E-07	.15221368E-03
.10000000E+01	.96863908E-08	-.22080642E-09	-.21316144E-08	-.16738301E-09
.50310155E-09	.51220876E-10	.71524564E-09	-.31071253E-10	-.15880740E-08
.18206492E-08	.32317686E-09	.10031900E-09	.78252621E-09	.57321209E-10
-.22089988E-09	-.45855306E-08	-.61200326E-08	-.80736291E-10	-.20094994E-09
-.18289443E-09	.81538381E-10	-.10441846E-08	-.86338705E-08	.96863908E-08
.10000000E+01	-.83286638E-10	-.96200651E-10	-.75748973E-09	.64933845E-09
-.26895791E-10	-.97338757E-12	-.47158520E-11	.25789669E-09	-.13561120E-09
.12105915E-10	-.36641097E-10	.33675814E-11	.72512622E-11	-.12869248E-10
.76304768E-09	.51696454E-09	.38873326E-11	.18211917E-10	.56313574E-11
.34212015E-10	-.14603011E-11	.45921242E-09	-.22080646E-09	-.83286638E-10
.10000000E+01	.58959486E-05	.14665321E-07	-.85539216E-08	-.46932053E-10
-.79781317E-10	-.13956592E-11	-.98514661E-10	-.12897281E-08	-.55168990E-10
-.81560497E-10	-.57812195E-10	.43261077E-11	.38339013E-10	-.90324783E-09
.41021164E-08	-.52248843E-11	.26472063E-10	-.72942198E-11	.38356856E-10

```
 .73313071E-10 -.20521064E-09 -.21316143E-08 -.96200651E-10  .58959486E-05
 .10000000E+01 -.59777300E-08 -.75550117E-07 -.51456404E-09 -.28504694E-10
 .40931813E-11 -.37720340E-09 -.25829159E-10  .27914248E-09 -.45187665E-09
 .11108611E-09  .42475879E-11 -.31448481E-09 -.10747487E-08  .38755748E-10
 .43195040E-10  .16702574E-09 -.17559408E-10  .24612970E-10 -.10191791E-09
-.89116176E-09 -.16738308E-09 -.75748973E-09  .14665321E-07 -.59777301E-08
 .10000000E+01 -.11866292E-03 -.16699269E-09 -.24628016E-08 -.13308932E-09
 .27460630E-09  .16156571E-09  .14656790E-09 -.93057434E-09 -.29422474E-08
 .23009307E-09 -.18544250E-09  .61285545E-09 -.28087069E-09 -.10247581E-09
-.34247066E-09 -.32344202E-10  .46331502E-09  .14986050E-08  .26024357E-09
 .50310165E-09  .64933845E-09 -.85539216E-08 -.75550117E-07 -.11866292E-03
 .10000000E+01
damping matrix
 .39515996E-02  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .39516161E-02  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .57051589E-02  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .10312256E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .10312269E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .11723114E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .18482064E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .18482067E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .21730454E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .26395027E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .33015249E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .33015287E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
```

```
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .85110374E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .96499772E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .12323587E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14322839E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14322847E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14874285E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14874293E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .16365219E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23335965E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23335978E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23420770E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23420782E+00
 stiffness matrix
 .97594620E-02 -.29562935E-03 -.75027124E-09  .72025612E-08  .32076552E-08
 .12842036E-08 -.90451014E-10 -.17520828E-09  .61166345E-10 -.19514395E-09
 .20449663E-08 -.59903455E-09  .11734955E-11 -.11566431E-11  .82897331E-12
 .18224390E-11  .91230355E-12  .33761495E-10  .12195177E-10  .39046523E-12
-.23182122E-12 -.45045983E-12 -.50303460E-11 -.16273291E-11 -.29563182E-03
 .97595435E-02  .26340700E-09  .24106267E-09  .33302668E-07  .19099210E-09
 .17684183E-09 -.21551112E-09 -.30152319E-10 -.62306491E-11  .13513914E-08
-.89381996E-08  .28259460E-11 -.90398944E-11  .13342475E-11 -.81528791E-12
-.22587225E-11  .35773535E-11  .13680596E-09  .72885717E-11  .13210152E-12
-.79094623E-12 -.24557427E-12 -.23989233E-10 -.15639020E-08  .54905123E-09
 .20343024E-01 -.26079975E-09  .48565154E-08  .94600863E-09  .98901407E-10
-.64254611E-10 -.19314411E-11 -.11407272E-09  .99913434E-10 -.10561077E-08
```

-.12958944E-12	.94279651E-12	.10015730E-12	-.57997122E-12	.18743726E-12
-.33130988E-12	.15637630E-10	-.59105368E-12	-.93439414E-13	-.27921324E-13
.81773561E-13	-.27093940E-11	.49050780E-07	.16417779E-08	-.85207293E-09
.66464133E-01	.19475411E-03	.70269359E-07	-.16237297E-07	.45511788E-08
.61626102E-10	-.42892336E-08	.10795968E-08	.57553439E-09	.48250404E-10
.10784259E-09	-.75078960E-11	.38099994E-11	-.29288332E-10	-.68250243E-10
-.33409452E-10	-.10524932E-09	.17471826E-10	-.66418785E-11	-.25134243E-10
.18277811E-10	.21845110E-07	.22679724E-06	.15867112E-07	.19475462E-03
.66464305E-01	.47315439E-07	-.35768462E-07	-.10346396E-06	.55332801E-08
-.29915172E-08	-.29780635E-08	.11768222E-08	-.11051827E-09	-.28583534E-09
-.13254065E-10	.13294086E-09	.38057802E-09	-.48296946E-10	.62028220E-10
.12099541E-09	-.92194702E-11	-.85621868E-10	-.16899667E-11	.10770092E-10
.11302504E-07	.16809534E-08	.39943453E-08	.90812287E-07	.61147734E-07
.85894623E-01	-.71430461E-08	.20915017E-08	.96492788E-09	.86143002E-08
-.10576290E-07	.60241884E-08	-.11344353E-09	.24197689E-09	-.10012414E-09
.19655470E-10	-.25911887E-10	-.12651469E-09	-.11260067E-09	.27711122E-10
.10422433E-11	-.47322329E-11	.23975455E-10	.12585346E-10	-.19775410E-08
.38697774E-08	.10379095E-08	-.52157042E-07	-.11489221E-06	-.17754025E-07
.21349168E+00	-.21187502E-01	.47810000E-08	-.85307615E-08	.68817988E-07
-.10708940E-06	.50448730E-10	-.46755022E-10	.30712267E-10	.33803654E-10
.15965556E-10	.69886272E-09	.12220632E-08	.21628280E-10	-.78725297E-11
-.17381897E-10	-.96488084E-10	-.19868499E-09	-.38323239E-08	-.47144921E-08
-.67436058E-09	.14619108E-07	-.33233900E-06	.51984276E-08	-.21187509E-01
.21349175E+00	-.42856447E-08	.35137127E-08	.33059276E-07	-.33370775E-06
.62597345E-10	-.21700140E-09	.25569023E-10	-.43772625E-10	-.89149742E-10
-.12003948E-09	.35860843E-08	.16675823E-09	.65427100E-12	-.12334270E-10
.23731088E-10	-.62821713E-09	.18497242E-08	-.91183816E-09	-.28036982E-10
.27364911E-09	.24570374E-07	.33154821E-08	.66093311E-08	-.59245192E-08
.29513290E+00	.37519809E-08	-.69733084E-08	.44873745E-07	.28192923E-11
-.19683526E-10	-.11199895E-12	.17068733E-10	-.10047449E-10	-.16608589E-10
-.39748348E-09	.16947454E-10	.21308173E-11	.12755192E-11	.12553181E-11
.67910129E-10	-.87066875E-08	-.27779292E-09	-.24417141E-08	-.28100677E-07
-.19598723E-07	.43669505E-07	-.17399277E-07	.71665128E-08	.55356311E-08
.43543590E+00	.14810812E-06	-.84720111E-07	.53455607E-09	-.10077465E-08
.39621050E-09	-.90142789E-10	.11631096E-09	.76132617E-09	.62634874E-09
-.96162869E-10	-.55908969E-11	.16693329E-10	-.13693987E-09	-.80752431E-10
.14274801E-06	.94331868E-07	.33459029E-08	.11065514E-07	-.30525020E-07
-.83883518E-07	.21959873E-06	.10549258E-06	-.16096458E-07	.23172014E-06
.68125418E+00	-.27104561E-01	.11614789E-08	.26490362E-08	-.31716511E-09
.85943274E-09	.90728701E-09	-.29221317E-08	.50490366E-09	-.31241205E-08
.51957049E-09	-.61526398E-09	-.73211418E-09	.41751702E-09	-.41815403E-07
-.62392289E-06	-.35367329E-07	.58996564E-08	.12062234E-07	.47779635E-07
-.34172432E-06	-.10648671E-05	.10358214E-06	-.13254778E-06	-.27104623E-01
.68125575E+00	.42582183E-08	.10332833E-07	.43797025E-09	-.43936896E-08
-.13188862E-07	.99646725E-09	-.27074259E-08	-.41693831E-08	.35204549E-09
.27946747E-08	.26429309E-10	-.19132813E-09	.54370530E-09	.12885390E-08
-.26094123E-10	.32796145E-08	-.75165501E-08	-.59794170E-08	.10704220E-08
.13302950E-08	.43492383E-10	.55578312E-08	.77190818E-08	.28298716E-07
.45273599E+01	.33289908E-09	.17573194E-09	.16686711E-09	.32812234E-09
-.13993111E-08	.35471410E-08	-.36583693E-09	.17545295E-10	-.23583057E-10
.19549301E-09	-.46399077E-09	-.68383088E-09	-.53715190E-08	.26488114E-09
.94548621E-08	-.25067621E-07	.16397539E-07	-.12751511E-08	-.59152219E-08
-.38826234E-09	-.13469743E-07	.22631843E-07	.88273977E-07	.42812130E-09
.58201288E+01	-.90943330E-09	-.36104962E-10	-.15585213E-08	-.61692245E-08
.16972432E-07	-.11689674E-08	.10556426E-09	.15428061E-09	.97207921E-09
-.19932091E-08	.84272535E-09	.12524416E-08	.42753780E-10	-.10640459E-08
-.19639654E-08	-.11067963E-07	.13620121E-08	.11243940E-08	-.22333246E-11
.86371992E-08	-.44220668E-08	.60963545E-08	.36836949E-09	-.14823860E-08
.94919248E+01	.11569532E-08	.14240477E-08	.23390508E-08	.39891144E-08
-.17362158E-08	.53773057E-10	-.69087488E-10	-.16684484E-09	-.30710330E-09
.23825826E-08	-.10705752E-08	-.36680513E-09	.71712112E-09	.25667901E-07
.29338338E-08	.20318696E-08	-.26286568E-08	.74191582E-09	-.26544722E-08
.16176156E-07	-.82690075E-07	.47275881E-09	-.79170095E-10	.15625947E-08
.12821483E+02	-.41877293E-03	-.56342791E-07	-.31992622E-06	.10454387E-08
.43863811E-09	.49179440E-09	.31556405E-09	.59403734E-08	.11999282E-08
-.29567965E-08	.11817227E-09	-.56627605E-08	.73391744E-07	-.38683881E-08
.95862784E-09	-.53555396E-08	-.43655302E-09	.34248007E-08	.17076716E-07
-.24822099E-06	.92912736E-09	-.34332976E-08	.19234540E-08	-.41877339E-03
.12821497E+02	.54236081E-07	-.93850374E-06	-.13387797E-07	-.18793480E-10
.94000040E-09	-.13067391E-08	.19214341E-07	.47846913E-07	.51256077E-08
-.22527256E-09	-.14182629E-07	-.10032981E-07	-.20366924E-07	.45262964E-07

```
-.77773881E-08 -.77815894E-09  .24176875E-07 -.59312892E-07  .20227043E-07
-.42740708E-08 -.14657279E-07  .34081278E-08 -.60764954E-07  .58492524E-07
 .13827771E+02  .21047759E-02 -.11938795E-06  .63495967E-08 -.28372832E-08
-.12322523E-07  .35987854E-08  .17313572E-07  .19380609E-06  .10627946E-07
-.69339030E-08  .12880785E-07 -.18128101E-07  .79148965E-07  .23226738E-06
-.18623154E-07  .19890436E-07  .10247543E-07 -.54955412E-07  .10833735E-07
 .40324285E-07  .58103208E-08 -.34503589E-06 -.10121617E-05  .21047783E-02
 .13827787E+02  .13394160E-06 -.30532164E-08 -.29475699E-07 -.23147128E-08
 .69566688E-08  .85737493E-09  .11972471E-07 -.52009481E-09 -.26582230E-07
 .30475180E-07  .54095867E-08  .16790539E-08  .13098546E-07  .95948868E-09
-.36975908E-08 -.76756243E-07 -.10244206E-06 -.13514731E-08 -.33636087E-08
-.30612494E-08  .13646379E-08 -.17478437E-07 -.14452064E-06  .16213823E-06
 .16738775E+02 -.13945359E-08 -.16103805E-08 -.12679180E-07  .10869214E-07
-.91550650E-09 -.33334156E-10 -.16050637E-09  .87776220E-08 -.46153852E-08
 .41203041E-09 -.12472661E-08  .11467520E-09  .24680008E-09 -.43801066E-09
 .25970692E-07  .17595245E-07  .13230540E-09  .61985082E-09  .19168201E-09
 .11644931E-08 -.49596044E-10  .15629549E-07 -.75152029E-08 -.28347009E-08
 .34035455E+02  .20067129E-03  .49914084E-06 -.29113677E-06 -.15969909E-08
-.27153113E-08 -.47502223E-10 -.33529005E-08 -.43896635E-07 -.18777036E-08
-.27762546E-08 -.19675833E-08  .14724131E-09  .13048872E-08 -.30742521E-07
 .13961746E-06 -.17783387E-09  .90098960E-09 -.24823965E-09  .13055799E-08
 .24952241E-08 -.69844069E-08 -.72550516E-07 -.32742397E-08  .20067151E-03
 .34035491E+02 -.20345508E-06 -.25713854E-05 -.17642842E-07 -.97773383E-09
 .14035968E-09 -.12931820E-07 -.88486304E-09  .95699556E-08 -.15492845E-07
 .38072643E-08  .14565520E-09 -.10781761E-07 -.36845727E-07  .13291458E-08
 .14814849E-08  .57271389E-08 -.60505547E-09  .84480496E-09 -.34929367E-08
-.30551212E-07 -.57376276E-08 -.25966143E-07  .50277715E-06 -.20493817E-06
 .34283278E+02 -.40681539E-02 -.57248771E-08 -.84432571E-07 -.45627666E-08
 .94143010E-08  .55387795E-08  .50248116E-08 -.31901744E-07 -.10086897E-06
 .78883295E-08 -.63574471E-08  .21010657E-07 -.96293667E-08 -.35136868E-08
-.11741684E-07 -.11054520E-08  .15883512E-07  .51376341E-07  .89214834E-08
 .17247322E-07  .22259068E-07 -.29325792E-06 -.25901072E-05 -.40681582E-02
 .34283314E+02
        *** zeroth order terms ***


 alpha
-.42285318E-07  .22032523E-08  .19103434E-08 -.46164709E-09 -.25254923E-07
 .15319234E-08 -.92689514E-10 -.41002187E-09 -.56423913E-10  .53935514E-09
 .39637933E-10 -.80781973E-09  .34687579E-10 -.27100970E-09  .57689693E-10
-.98124081E-10  .42222814E-08  .46766094E-10 -.23190343E-08 -.21012612E-09
 .84068331E-10  .67994729E-09 -.13698436E-08  .62753410E-10  .11096251E-10
 .39006386E-10  .73868759E-11  .27987870E-11 -.62247277E-09 -.59775470E-11
 .17590884E-09  .76219460E-11 -.26366890E-09  .11876573E-10  .28290161E-10
-.27201298E-10  .89869863E-12 -.15751250E-11 -.33157375E-12  .70866876E-12
-.24551181E-11 -.42785452E-10  .34373229E-12  .11944186E-12 -.30843212E-12
 .15203202E-10  .15923719E-12 -.27557073E-12 -.68722572E-12  .78199706E-11
-.53600279E-12  .35222275E-11 -.10833770E-12 -.38667210E-11  .24012255E-12
-.22349588E-13  .72325799E-13 -.72369183E-12  .14903493E-11  .24910814E-10
 .17123480E-11  .30860344E-13  .45896282E-13  .35510380E-13 -.12439625E-11
 .66833265E-13 -.45804903E-12 -.82105459E-14  .84237205E-12  .62945655E-13
-.81003566E-13  .43653901E-13
 h matrix
-.41919760E+00  .56538237E+00 -.43485534E-01 -.48726399E+01 -.14092839E+00
 .31621688E+00 -.15658688E+00 -.17361672E-01 -.21636943E-02 -.21186125E-01
 .26295445E+00  .10634541E-02  .39837270E+00  .24038060E-01  .34138213E-02
 .72810429E-01 -.66125938E-01 -.14508666E-01 -.87470672E-01  .13982584E-01
 .20325687E-02 -.26138318E+00 -.13271355E-01  .17000778E-01  .16625637E-01
-.30466702E-03  .92471384E-04 -.13678233E-01  .14351589E-01  .35179758E-02
 .18275688E-02  .81441214E-01  .37327408E-03 -.11565896E+00 -.94944608E-03
-.86128442E-03 -.44776941E-03 -.16313018E-03 -.15718717E-04 -.10522228E-02
 .90631992E-05  .49761828E-04 -.64926039E-04  .27152761E-04 -.19410130E-04
 .46028011E-03  .13453022E-03  .19224888E-06  .13666807E-02  .14309527E-03
-.11088438E-03 -.18934576E-03  .15159582E-02  .53961923E-05  .20500426E-02
 .20016096E-03  .90999899E-05  .44426853E-03  .45524403E-04  .33906200E-05
-.32663380E-04 -.43305067E-04 -.94350657E-07 -.31076189E-03  .13804808E-04
 .12272265E-04 -.36541686E-04 -.23880534E-03 -.33501440E-06 -.17757456E-03
-.13655382E-03 -.30751912E-05
 s1
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
```

```
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00
  *** first order terms ***

 i_1  m_i^b
 .89381792E-01  .00000000E+00  .00000000E+00  .00000000E+00  .89381792E-01
 .00000000E+00 -.58177179E+00 -.43307251E+00  .00000000E+00 -.10178988E+01
 .00000000E+00  .00000000E+00  .00000000E+00 -.10178988E+01  .00000000E+00
 .15376649E+00 -.50245233E+01  .00000000E+00  .71852291E-02  .00000000E+00
 .00000000E+00  .00000000E+00  .71852291E-02  .00000000E+00  .28424090E-01
-.17291849E+00  .00000000E+00 -.10551282E-01  .00000000E+00  .00000000E+00
 .00000000E+00 -.10551282E-01  .00000000E+00 -.40492477E+05 -.23515802E+04
 .00000000E+00 -.31408004E-01  .00000000E+00  .00000000E+00  .00000000E+00
-.31408004E-01  .00000000E+00  .22328507E+04 -.40498476E+05  .00000000E+00
 .33870978E+05  .00000000E+00  .00000000E+00  .00000000E+00  .33870978E+05
 .00000000E+00  .24388227E-01  .23658852E-01  .00000000E+00  .31851587E-01
 .00000000E+00  .00000000E+00  .00000000E+00  .31851587E-01  .00000000E+00
-.16187775E-01 -.96444085E-01  .00000000E+00 -.53418857E-01  .00000000E+00
 .00000000E+00  .00000000E+00 -.53418857E-01  .00000000E+00  .12105322E-01
-.28935991E+00  .00000000E+00 -.11132880E-03  .00000000E+00  .00000000E+00
 .00000000E+00 -.11132880E-03  .00000000E+00 -.11476862E-02  .30969398E-01
 .00000000E+00 -.22321987E+05  .00000000E+00  .00000000E+00  .00000000E+00
-.22321987E+05  .00000000E+00 -.31998031E-01 -.29477051E-01  .00000000E+00
 .11286377E-02  .00000000E+00  .00000000E+00  .00000000E+00  .11286377E-02
 .00000000E+00 -.59876589E+05 -.98431220E+04  .00000000E+00 -.35882781E-02
 .00000000E+00  .00000000E+00  .00000000E+00 -.35882781E-02  .00000000E+00
-.74530641E+04  .60220631E+05  .00000000E+00  .34407691E+06  .00000000E+00
 .00000000E+00  .00000000E+00  .34407691E+06  .00000000E+00 -.20702927E-04
 .84613530E-04  .00000000E+00 -.20271109E-05  .00000000E+00  .00000000E+00
 .00000000E+00 -.20271109E-05  .00000000E+00  .60214464E-02  .31309394E-02
 .00000000E+00  .21803208E+06  .00000000E+00  .00000000E+00  .00000000E+00
 .21803208E+06  .00000000E+00  .35046731E-06  .20448791E-05  .00000000E+00
```

.13462938E+00	.00000000E+00	.00000000E+00	.00000000E+00	.13462938E+00
.00000000E+00	.25977374E-05	.10399210E-03	.00000000E+00	-.81973301E-01
.00000000E+00	.00000000E+00	.00000000E+00	-.81973301E-01	.00000000E+00
-.15155120E-04	.18537988E-03	.00000000E+00	-.55950132E-05	.00000000E+00
.00000000E+00	.00000000E+00	-.55950132E-05	.00000000E+00	-.50422495E+04
-.40884484E+02	.00000000E+00	-.70074319E-03	.00000000E+00	.00000000E+00
.00000000E+00	-.70074319E-03	.00000000E+00	.40113806E+02	-.50422499E+04
.00000000E+00	-.10789343E-03	.00000000E+00	.00000000E+00	.00000000E+00
-.10789343E-03	.00000000E+00	-.15519734E-03	.54725953E-02	.00000000E+00
-.15473569E-01	.00000000E+00	.00000000E+00	.00000000E+00	-.15473569E-01
.00000000E+00	-.44691498E-04	.61545868E-04	.00000000E+00	-.16490171E-01
.00000000E+00	.00000000E+00	.00000000E+00	-.16490171E-01	.00000000E+00
.70316673E-04	.10593837E-03	.00000000E+00	-.22504118E-05	.00000000E+00
.00000000E+00	.00000000E+00	-.22504118E-05	.00000000E+00	-.30912152E+04
.15565069E+04	.00000000E+00	.66447651E-04	.00000000E+00	.00000000E+00
.00000000E+00	.66447651E-04	.00000000E+00	-.15561377E+04	-.30913985E+04
.00000000E+00				

gamma_2 y_ki^b

-.62607851E-07	-.50794938E-06	.17478712E-01	.51856264E-06	-.78861303E-08
-.10052474E+01	-.73381075E-03	-.13366523E-01	.45386799E-06	.36717330E-07
.34244087E-06	.21280028E-06	-.34124540E-06	.38838113E-07	-.21262985E-06
-.33159527E-07	.43796371E-07	-.24642116E-05	.13404742E-06	-.82364180E-06
.18701826E-02	.80726494E-06	.22112481E-06	.17620561E-01	-.53324649E-02
-.28274991E-01	-.60964083E-07	.18974310E-07	-.16027134E-07	.26374269E-06
.21157972E-08	-.24413690E-06	-.10930903E-06	-.24235997E-06	.10887613E-07
-.13773702E-06	-.74355275E-06	.86344820E-06	-.86348556E-08	-.10594211E+00
-.72922176E-01	.12741219E-07	-.80583169E-06	.12968028E-05	-.14501437E-06
-.91143541E-07	.15942143E-06	-.12557840E+00	-.16085783E-06	-.84422487E-07
.47379413E+00	-.16763984E-06	-.73009900E-06	.48745525E-06	-.27553639E-06
-.28304144E-05	-.20161874E-06	-.21301848E+00	-.18980035E+01	-.16449225E-07
-.15146456E-06	-.22667613E-06	-.27864015E+00	-.22686122E-06	.15001301E-06
-.75692354E+00	.85227134E-07	.54382657E-06	-.11012196E-05	.35436475E-07
.14708492E-05	.62332048E-06	-.51856264E-06	.78861303E-08	.10052474E+01
.38444042E-06	-.36081121E-07	.17478850E-01	.13382617E-01	-.32858247E-03
-.72393559E-07	-.19119526E-07	-.39108756E-06	.34672207E-05	.38988118E-06
-.19214899E-07	-.15281638E-07	-.38279177E-06	-.12413706E-07	-.11021283E-06
.99446352E-07	-.60651059E-06	-.17943828E-01	.58761898E-06	.15995717E-06
.31010888E-02	.28423613E-01	-.44735140E-02	.26039509E-08	.16609008E-06
.45472414E-07	.37293498E-07	-.10498110E-06	.45860445E-06	-.93834662E-06
.45908021E-06	.88219631E-07	.18403367E-06	-.78571358E-05	-.80752560E-06
-.22489195E-06	.76105503E-01	-.10368437E+00	.15769748E-08	-.10568617E-04
.57565891E-06	.76217949E-06	-.74044170E-07	.11391547E-06	-.46976639E+00
-.12058674E-06	-.75683469E-07	-.13985513E+00	.10506104E-05	.54053200E-06
.30253741E-05	.21515236E-05	.12619873E-06	.20116967E-05	.19035792E+01
-.15542683E+00	-.27743136E-08	-.12645160E-06	-.20146267E-06	-.74812742E+00
-.20000508E-06	.12631014E-06	.30143385E+00	-.10593951E-05	-.15030137E-05
-.77536846E-05	.10054546E-06	-.52218327E-06	-.39275247E-05	.73381075E-03
.13366523E-01	-.45386799E-06	-.13382617E-01	.32858247E-03	.72393559E-07
.54588498E-07	-.11666072E-07	.14310395E-13	-.71385118E-09	.88880863E-08
.18767167E-06	.19211684E-08	.68511270E-09	.23711830E-07	.25343822E-07
-.10409501E-07	.56561332E-12	-.21846001E-01	.12358662E+00	.57679267E-07
-.12080850E+00	-.34003255E-01	-.19362683E-07	-.45282224E-07	.61839009E-08
.75797873E-14	.13743203E-06	.22855908E-08	-.88236331E-13	-.28600792E-09
.22856711E-07	-.87464909E-07	-.79568074E-08	.51110757E-09	.14175266E-07
-.23010227E-06	-.98727685E-07	.43416653E-13	-.24898360E-06	.91483883E-07
-.77664092E-13	-.45284969E-06	.42741722E-07	-.21249170E-12	-.13278546E-01
-.52285061E-01	.14719014E-06	.52285564E-01	-.13276810E-01	-.63399074E-08
-.26217801E-08	-.39483112E-08	.92799969E-07	.35017562E-08	-.20853839E-08
.83171247E-07	-.65246642E-06	.17160470E-06	-.41382889E-12	-.23320671E-01
-.71358750E-01	.15696020E-06	-.71358882E-01	.23320214E-01	-.38814806E-07
.47261019E-08	.11104159E-07	-.25209767E-06	-.82271192E-08	.34017979E-08
-.17927404E-06	-.36717330E-07	-.34244087E-06	-.21280028E-06	.19119526E-07
.39108756E-06	-.34672207E-05	.71385118E-09	-.88880863E-08	-.18767167E-06
.77264000E-09	.56089073E-08	.25542566E-01	-.54712968E-08	.45510576E-09
-.83092402E+00	-.28447933E-03	.22671016E-02	-.12113218E-05	-.56448434E-07
.24611815E-06	.73965692E-06	-.24294989E-06	-.44164116E-07	.23229657E-05
-.35178955E-09	-.14722675E-07	-.16092113E-06	.65717217E-02	.49474668E-01
.21395490E-06	-.14410719E-08	-.40903978E-08	.60441216E-01	-.11126326E-08
.49737407E-08	-.53923648E+00	-.94714179E-01	-.64899273E+00	-.34678836E-08
-.10559694E-07	-.39960159E-06	.37782460E-06	.13940018E+00	.12146079E+01
-.12958433E-08	.19372121E-06	.13219075E-05	.14943658E-08	.80698553E-07

-.19053734E-06	.77887080E-07	.39680923E-08	.64423900E-08	.19692464E-01
-.67860925E-08	.11108030E-08	-.36522737E-04	-.71710619E-08	-.46661594E-06
.20025118E-06	.65869035E-07	.31119132E-06	-.19170180E-07	-.48891040E-08
-.41439984E-06	-.18152134E-07	-.76837879E-08	-.16366625E-07	-.11419001E+00
.16399263E-07	-.73058140E-08	.94493068E-01	.34124540E-06	-.38838113E-07
.21262985E-06	-.38988118E-06	.19214899E-07	.15281638E-07	-.19211684E-08
-.68511270E-09	-.23711830E-07	.54712968E-08	-.45510576E-09	.83092402E+00
-.17031265E-07	.24014354E-08	.25542495E-01	-.22678700E-02	-.27782968E-03
.11184452E-05	.62194659E-07	-.47712538E-06	-.76244129E-07	.43215597E-06
.10569704E-06	.33350487E-07	-.71735340E-08	-.38147924E-09	.10918412E-07
-.49455263E-01	.67166526E-02	-.25146107E-06	-.93566548E-09	-.57381558E-08
-.53707875E+00	-.90587906E-08	.40903232E-08	-.40597617E-01	.64871410E+00
-.96615212E-01	-.60262836E-09	-.18891624E-06	-.98396479E-08	.89202189E-07
-.12141936E+01	.14295856E+00	.23050185E-09	-.14209128E-05	.23416354E-06
.35761913E-07	.15420580E-06	-.19440207E-07	.14128991E-08	.11873660E-07
.19292084E-07	.96879863E-04	-.16434235E-07	.11524456E-07	.19691541E-01
-.22074571E-06	-.15404011E-07	-.27221783E-06	-.28954207E-06	.78314182E-07
.29898828E-08	.42591726E-06	-.27558297E-07	-.32855064E-08	-.22910605E-07
-.48721700E-07	-.94812449E-01	.48349038E-07	-.22872252E-07	-.11390138E+00
.33159527E-07	-.43796371E-07	.24642116E-05	.38279177E-06	.12413706E-07
.11021283E-06	-.25343822E-07	.10409501E-07	-.56561332E-12	.28447933E-03
-.22671016E-02	.12113218E-05	.22678700E-02	.27782968E-03	-.11184452E-05
-.38364585E-09	-.37498631E-08	.35516869E-12	-.22295994E-07	-.84358887E-08
-.17454190E-05	-.61060311E-07	.22204943E-07	.56177629E-06	.13463461E-06
-.14755869E-07	-.18433634E-12	-.72183338E-07	.90190096E-07	-.75307473E-13
.36174635E-02	.19730933E-01	-.68628116E-06	.19571357E-01	-.43996180E-02
-.78227017E-06	.96672133E-06	-.11372652E-05	-.81782833E-13	.37524982E-05
-.34633772E-06	.73163584E-12	-.14240023E-05	.16913358E-05	.85314857E-12
-.30146541E-08	.35978002E-08	-.45661113E-06	-.42909184E-08	-.19153162E-08
.50616539E-07	-.12756037E-01	-.20183313E-01	-.54931006E-07	.20181394E-01
-.12759081E-01	.42808564E-07	.36247494E-05	-.29293728E-06	-.11631316E-12
-.31447785E-08	-.59196241E-08	.10223336E-07	-.49032229E-08	.29885627E-08
.83085912E-07	.26910936E-01	.53138454E-01	-.10396571E-06	-.53141657E-01
.26904645E-01	-.94708623E-07	-.13404742E-06	.82364180E-06	-.18701826E-02
-.99446352E-07	.60651059E-06	.17943828E-01	.21846001E-01	-.12358662E+00
-.57679267E-07	.56448434E-07	-.24611815E-06	-.73965692E-06	-.62194659E-07
.47712538E-06	.76244129E-07	.22295994E-07	.84358887E-08	.17454190E-05
.47263847E-08	-.24842569E-07	-.74612173E-02	.33702520E-07	.52587698E-08
-.99165381E+00	-.24130997E-02	.27251892E-01	-.20230691E-06	.42383207E-07
-.11484143E-07	.90215619E-06	-.40538688E-08	.59415338E-07	.40772390E-06
-.88506639E-09	-.26291127E-07	.93122118E-07	-.70112029E-06	.18615170E-06
-.27093746E-06	-.11513953E+00	.10016519E+01	.10444111E-07	.66967927E-06
-.22081894E-06	.29618344E-06	-.36225913E-08	.85213715E-08	-.40353386E-01
-.80313089E-08	-.50214583E-08	.13026438E+00	-.79053746E-07	.70869914E-06
.84282940E-07	.96353235E-10	.81235041E-06	.18225686E-07	.92446699E-02
.36511561E+00	-.12675867E-07	-.57668967E-08	-.84437859E-08	-.19320351E-01
-.83112891E-08	.55592945E-08	-.12118342E+00	.37021885E-07	-.17801169E-06
-.12499195E-06	-.55451004E-07	-.26193636E-06	.18332552E-07	-.80726494E-06
-.22112481E-06	-.17620561E-01	-.58761898E-06	-.15995717E-06	-.31010888E-02
.12080850E+00	.34003255E-01	.19362683E-07	.24294989E-06	.44164116E-07
-.23229657E-05	-.43215597E-06	-.10569704E-06	-.33350487E-07	.61060311E-07
-.22204943E-07	-.56177629E-06	-.33702520E-07	-.52587698E-08	.99165381E+00
.19757764E-07	.81710904E-08	-.74615305E-02	-.26877854E-01	-.51057423E-02
.67961445E-07	.12974058E-06	-.90406751E-08	-.26684890E-06	-.65884970E-07
.26442837E-06	.13464373E-05	.30067542E-06	-.20275997E-08	.86886469E-07
-.21444915E-05	.11187428E-06	-.77099669E-07	-.98527966E+00	-.21397787E+00
-.14263427E-08	.20740004E-05	-.23288741E-06	.46545419E-07	.87483772E-09
.17211154E-07	-.12561504E+00	-.15869406E-07	.14981146E-08	-.53077809E-01
-.69826092E-06	-.93248306E-07	.23220378E-06	-.86409724E-06	-.81421980E-07
.11449558E-06	-.36422996E+00	-.27036148E-01	.14001264E-08	.48725385E-08
.12206505E-07	-.11866768E+00	.12399628E-07	-.47190946E-08	.31250391E-01
.23088390E-06	-.32957092E-07	-.37125093E-06	.35360159E-06	.28254188E-07
-.38520272E-07	.53324649E-02	.28274991E-01	.60964083E-07	-.28423613E-01
.44735140E-02	-.26039509E-08	.45282224E-07	-.61839009E-08	-.75797873E-14
.35178955E-09	.14722675E-07	.16092113E-06	.71735340E-08	.38147924E-09
-.10918412E-07	-.13463461E-06	.14755869E-07	.18433634E-12	.24130997E-02
-.27251892E-01	.20230691E-06	.26877854E-01	.51057423E-02	-.67961445E-07
-.19610946E-09	-.12793244E-08	-.40284160E-14	-.83006278E-07	.16727198E-07
-.31503409E-13	-.12027390E-08	-.79489702E-08	-.94373911E-07	-.70395759E-09
-.24600259E-09	-.61037343E-08	.20879089E-06	-.14299961E-07	-.29220077E-13
-.15107758E-06	.17930787E-07	.35600382E-13	-.18459429E-06	.73257490E-07

.32197615E-13	-.11934809E-01	-.24773363E-01	-.28562365E-07	.24773764E-01
-.11933949E-01	.10299928E-08	.93398544E-10	.13727412E-09	-.23093011E-07
-.54977989E-09	.38611032E-09	-.12072820E-07	-.34175860E-07	.90726267E-08
.25781137E-13	-.30017386E-01	-.48004147E-01	-.21394263E-07	-.48004340E-01
.30017176E-01	-.16597444E-08	.15204283E-09	-.22344016E-10	.41855726E-07
.19779770E-08	-.13203123E-08	.89135235E-08	-.18974310E-07	.16027134E-07
-.26374269E-06	-.16609008E-06	-.45472414E-07	-.37293498E-07	-.13743203E-06
-.22855908E-08	.88236331E-13	-.65717217E-02	-.49474668E-01	-.21395490E-06
.49455263E-01	-.67166526E-02	.25146107E-06	.72183338E-07	-.90190096E-07
.75307473E-13	-.42383207E-07	.11484143E-07	-.90215619E-06	-.12974058E-06
.90406751E-08	.26684890E-06	.83006278E-07	-.16727198E-07	.31503409E-13
.10960857E-07	-.12663272E-07	-.12636246E-13	-.19959259E-02	.72617544E-01
.79350189E-07	.72639356E-01	-.89484432E-03	.11343359E-06	-.16459085E-06
.21258826E-06	.17755656E-12	.50741177E-06	-.65700277E-07	-.13810761E-12
.12668197E-06	-.19034335E-06	-.24898461E-12	.48485096E-09	-.38632258E-09
.20325780E-06	.53522249E-09	.18948680E-10	.27623676E-08	.84150598E-02
.17168433E-01	.34115338E-07	-.17167179E-01	.84177208E-02	-.13940941E-07
-.51059035E-07	-.57298172E-07	.20698406E-13	.94233533E-10	.50069943E-09
.11013082E-06	.50976879E-11	-.19275352E-09	.15874235E-08	-.41887505E-02
-.31354146E-01	-.46431865E-07	.31354628E-01	-.41849538E-02	.36824273E-07
-.21157972E-08	.24413690E-06	.10930903E-06	.10498110E-06	-.45860445E-06
.93834662E-06	.28600792E-09	-.22856711E-07	.87464909E-07	.14410719E-08
.40903978E-08	-.60441216E-01	.93566548E-09	.57381558E-08	.53707875E+00
-.36174635E-02	-.19730933E-01	.68628116E-06	.40538688E-08	-.59415338E-07
-.40772390E-06	.65884970E-07	-.26442837E-06	-.13464373E-05	.12027390E-08
.79489702E-08	.94373911E-07	.19959259E-02	-.72617544E-01	-.79350189E-07
-.70696657E-10	.59061577E-09	.15406909E-02	-.20017513E-08	-.22674296E-08
.18271839E+00	-.29420640E-01	.35553316E+00	.10890627E-08	-.22036796E-08
.72972846E-07	-.18535266E-06	.15383984E-02	-.28931664E+00	.30106500E-09
.35186887E-07	-.34894224E-06	-.12497649E-08	-.41746864E-07	.22875467E-07
.45437189E-07	-.42673819E-09	-.78136072E-09	.29073755E-01	.83848781E-09
-.30068531E-10	-.41762028E-01	.54019335E-08	-.52857311E-07	.69439023E-07
.39767875E-07	.76296204E-08	-.21121434E-08	.11553120E-06	.45920329E-07
-.21718772E-07	.44647683E-09	.16416114E-08	-.28098883E-01	-.16609482E-08
.44578552E-09	.79066663E-01	.24235997E-06	-.10887613E-07	.13773702E-06
-.45908021E-06	-.88219631E-07	-.18403367E-06	.79568074E-08	-.51110757E-09
-.14175266E-07	.11126326E-08	-.49737407E-08	.53923648E+00	.90587906E-08
-.40903232E-08	.40597617E-01	-.19571357E-01	.43996180E-02	.78227017E-06
.88506639E-09	.26291127E-07	-.93122118E-07	-.30067542E-06	.20275997E-08
-.86886469E-07	.70395759E-09	.24600259E-09	.61037343E-08	-.72639356E-01
.89484432E-03	-.11343359E-06	.20017513E-08	.22674296E-08	-.18271839E+00
-.15690317E-08	.10989807E-09	.15406299E-02	.35642111E+00	.15252056E-01
-.15551538E-09	.11525644E-08	.22841308E-08	.53271028E-07	-.28914783E+00
.99735803E-02	-.80529120E-11	-.39209234E-06	.26942708E-07	-.40357060E-08
-.23699116E-07	-.12256696E-08	.39578955E-08	.13718954E-08	.23672818E-08
-.42889921E-01	-.19728023E-08	.12993543E-08	-.27395597E-01	.10482756E-07
-.36015513E-08	.59618938E-07	-.98494637E-07	.30215091E-07	.83151351E-09
.11154142E-06	-.12729912E-07	-.22012824E-08	-.20575968E-08	-.54136933E-08
.80118470E-01	.54141545E-08	-.20376560E-08	.24921274E-01	.74355275E-06
-.86344820E-06	.86348556E-08	.78571358E-05	.80752560E-06	.22489195E-06
.23010227E-06	.98727685E-07	-.43416653E-13	.94714179E-01	.64899273E+00
.34678836E-08	-.64871410E+00	.96615212E-01	.60262836E-09	-.96672133E-06
.11372652E-05	.81782833E-13	.70112029E-06	-.18615170E-06	.27093746E-06
.21444915E-05	-.11187428E-06	.77099669E-07	-.20879089E-06	.14299961E-07
.29220077E-13	.16459085E-06	-.21258826E-06	-.17755656E-12	.29420640E-01
-.35553316E+00	-.10890627E-08	-.35642111E+00	-.15252056E-01	.15551538E-09
.19702911E-08	.17067919E-09	-.67397229E-14	.43502667E-06	.23008021E-06
-.18534110E-15	-.31921334E-09	-.49233010E-09	-.98795752E-14	-.46272789E-08
.32747580E-08	.41693501E-08	-.86543027E-08	.51209400E-08	-.21513879E-08
-.12962772E+00	-.22610792E+00	-.55780767E-10	.22608848E+00	-.12966222E+00
-.46893542E-10	-.63686977E-06	.54634427E-06	.37138548E-15	.86753266E-08
.74221774E-08	.46945470E-08	.16797908E-07	-.91574736E-08	.19556552E-08
.19954144E+00	.51982556E+00	.11311457E-09	-.51984922E+00	.19947944E+00
.51066096E-10	.10594211E+00	.72922176E-01	-.12741219E-07	-.76105503E-01
.10368437E+00	-.15769748E-08	.24898360E-06	-.91483883E-07	.77664092E-13
.10559694E-07	.39960159E-06	-.37782460E-06	.18891624E-06	.98396479E-08
-.89202189E-07	-.37524982E-05	.34633772E-06	-.73163584E-12	.11513953E+00
-.10016519E+01	-.10444111E-07	.98527966E+00	.21397787E+00	.14263427E-08
.15107758E-06	-.17930787E-07	-.35600382E-13	-.50741177E-06	.65700277E-07
.13810761E-12	.22036796E-08	-.72972846E-07	.18535266E-06	-.11525644E-08
-.22841308E-08	-.53271028E-07	-.43502667E-06	-.23008021E-06	.18534110E-15

-.12392972E-07	-.12119306E-08	-.18085362E-13	-.25448515E-06	-.24080342E-06
-.72100480E-15	.42365812E-01	.22743214E+00	.53395066E-09	-.22743389E+00
.42358362E-01	.13756098E-09	-.34009417E-09	-.36617465E-08	-.44502412E-08
.50488788E-08	-.25689226E-08	.32032115E-08	.14881036E-07	.20788290E-08
-.53416876E-14	.49700530E-01	.27168256E+00	.17278504E-09	.27168278E+00
-.49698521E-01	-.46204715E-10	-.72402280E-09	-.51155317E-09	.66103844E-08
-.10387562E-07	.27226537E-08	-.73095770E-08	.80583169E-06	-.12968028E-05
.14501437E-06	.10568617E-04	-.57565891E-06	-.76217949E-06	.45284969E-06
-.42741722E-07	.21249170E-12	-.13940018E+00	-.12146079E+01	.12958433E-08
.12141936E+01	-.14295856E+00	-.23050185E-09	.14240023E-05	-.16913358E-05
-.85314857E-12	-.66967927E-06	.22081894E-06	-.29618344E-06	-.20740004E-05
.23288741E-06	-.46545419E-07	.18459429E-06	-.73257490E-07	-.32197615E-13
-.12668197E-06	.19034335E-06	.24898461E-12	-.15383984E-02	.28931664E+00
-.30106500E-09	.28914783E+00	-.99735803E-02	.80529120E-11	.31921334E-09
.49233010E-09	.98795752E-14	.25448515E-06	.24080342E-06	.72100480E-15
.80857846E-09	-.65913199E-09	-.89837874E-14	-.40276693E-08	.23299565E-08
.33531355E-09	-.74204357E-08	.35521019E-08	.62833350E-08	-.82095560E-01
-.12224359E+00	-.26190706E-11	.12223122E+00	-.82113856E-01	-.75550354E-12
-.49434274E-06	.52138355E-06	-.36084625E-15	.72258733E-08	.45094717E-08
.82984545E-09	.11398262E-07	-.86245755E-08	-.84823258E-08	.20012965E+00
.34933873E+00	.29523672E-11	-.34936258E+00	.20008846E+00	-.35514320E-11
.91143541E-07	-.15942143E-06	.12557840E+00	.74044170E-07	-.11391547E-06
.46976639E+00	.13278546E-01	.52285061E-01	-.14719014E-06	-.19372121E-06
-.13219075E-05	-.14943658E-08	.14209128E-05	-.23416354E-06	-.35761913E-07
.30146541E-08	-.35978002E-08	.45661113E-06	.36225913E-08	-.85213715E-08
.40353386E-01	-.87483772E-09	-.17211154E-07	.12561504E+00	.11934809E-01
.24773363E-01	.28562365E-07	-.48485096E-09	.38632258E-09	-.20325780E-06
-.35186887E-07	.34894224E-06	.12497649E-08	.39209234E-06	-.26942708E-07
.40357060E-08	.46272789E-08	-.32747580E-08	-.41693501E-08	-.42365812E-01
-.22743214E+00	-.53395066E-09	.40276693E-08	-.23299565E-08	-.33531355E-09
-.13190608E-09	-.42992791E-09	.53549523E-03	.44221408E-09	-.15144278E-09
-.50250104E-02	-.53621168E-07	-.78323735E-07	-.76419772E-10	.67488837E-07
-.40301963E-07	.71900559E-10	-.38245326E-02	.95707833E-02	.28472227E-09
-.26263013E-09	-.59806850E-09	.30586106E-02	-.60005167E-09	.27669342E-09
.65749091E-02	.13037445E-06	.21701737E-06	.12705909E-09	-.21430064E-06
.12189418E-06	-.18933107E-09	.16085783E-06	.84422487E-07	-.47379413E+00
.12058674E-06	.75683469E-07	.13985513E+00	-.52285564E-01	.13276810E-01
.63399074E-08	-.80698553E-07	.19053734E-06	-.77887080E-07	-.15420580E-06
.19440207E-07	-.14128991E-08	.42909184E-08	.19153162E-08	-.50616539E-07
.80313089E-08	.50214583E-08	-.13026438E+00	.15869406E-07	-.14981146E-08
.53077809E-01	-.24773764E-01	.11933949E-01	-.10299928E-08	-.53522249E-09
-.18948680E-10	-.27623676E-08	.41746864E-07	-.22875467E-07	-.45437189E-07
.23699116E-07	.12256696E-08	-.39578955E-08	.86543027E-08	-.51209400E-08
.21513879E-08	.22743389E+00	-.42358362E-01	-.13756098E-09	.74204357E-08
-.35521019E-08	-.62833350E-08	-.44221408E-09	.15144278E-09	.50250104E-02
-.10011899E-08	.39672401E-09	.53548366E-03	.35302623E-07	.45619868E-07
-.18324191E-09	-.58945067E-07	.24482274E-07	-.14363279E-09	-.95706411E-02
-.38248253E-02	.52950837E-10	.80178997E-09	.17350601E-08	.65747891E-02
.17209949E-08	-.80376640E-09	-.30587738E-02	-.65962710E-07	-.12765379E-06
.24445245E-09	.13611625E-06	-.63215067E-07	.27202374E-09	.16763984E-06
.73009900E-06	-.48745525E-06	-.10506104E-05	-.54053200E-06	-.30253741E-05
.26217801E-08	.39483112E-08	-.92799969E-07	-.39680923E-08	-.64423900E-08
-.19692464E-01	-.11873660E-07	-.19292084E-07	-.96879863E-04	.12756037E-01
.20183313E-01	.54931006E-07	.79053746E-07	-.70869914E-06	-.84282940E-07
.69826092E-06	.93248306E-07	-.23220378E-06	-.93398544E-10	-.13727412E-09
.23093011E-07	-.84150598E-02	-.17168433E-01	-.34115338E-07	.42673819E-09
.78136072E-09	-.29073755E-01	-.13718954E-08	-.23672818E-08	.42889921E-01
.12962772E+00	.22610792E+00	.55780767E-10	.34009417E-09	.36617465E-08
.44502412E-08	.82095560E-01	.12224359E+00	.26190706E-11	.53621168E-07
.78323735E-07	.76419772E-10	-.35302623E-07	-.45619868E-07	.18324191E-09
.16412533E-11	.21384164E-11	.32021163E-03	.58936241E-11	-.14505988E-10
-.33385669E-02	-.42306378E-10	-.13863650E-08	.83012671E-08	-.56730240E-07
-.96467007E-07	-.10535633E-09	-.91711930E-07	.55460535E-07	-.51525169E-09
-.43381873E-11	-.92974491E-11	-.29258756E-02	.76083731E-11	.16981023E-11
.72526267E-02	.27553639E-06	.28304144E-05	.20161874E-06	-.21515236E-05
-.12619873E-06	-.20116967E-05	-.35017562E-08	.20853839E-08	-.83171247E-07
.67860925E-08	-.11108030E-08	.36522737E-04	.16434235E-07	-.11524456E-07
-.19691541E-01	-.20181394E-01	.12759081E-01	-.42808564E-07	-.96353235E-10
-.81235041E-06	-.18225686E-07	.86409724E-06	.81421980E-07	-.11449558E-06
.54977989E-09	-.38611032E-09	.12072820E-07	.17167179E-01	-.84177208E-02
.13940941E-07	-.83848781E-09	.30068531E-10	.41762028E-01	.19728023E-08

-.12993543E-08	.27395597E-01	-.22608848E+00	.12966222E+00	.46893542E-10
-.50488788E-08	.25689226E-08	-.32032115E-08	-.12223122E+00	.82113856E-01
.75550354E-12	-.67488837E-07	.40301963E-07	-.71900559E-10	.58945067E-07
-.24482274E-07	.14363279E-09	-.58936241E-11	.14505988E-10	.33385669E-02
-.45134366E-09	.30239391E-09	.32020344E-03	.31906173E-09	.34199546E-11
-.81669645E-08	-.30329414E-06	-.66271809E-06	-.35363609E-09	-.66144997E-06
.30804574E-06	.20159786E-09	-.57170319E-09	-.11035564E-08	-.72527212E-02
.10976139E-08	-.57328140E-09	-.29238966E-02	.21301848E+00	.18980035E+01
.16449225E-07	-.19035792E+01	.15542683E+00	.27743136E-08	.65246642E-06
-.17160470E-06	.41382889E-12	.71710619E-08	.46661594E-06	-.20025118E-06
.22074571E-06	.15404011E-07	.27221783E-06	-.36247494E-05	.29293728E-06
.11631316E-12	-.92446699E-02	-.36511561E+00	.12675867E-07	.36422996E+00
.27036148E-01	-.14001264E-08	.34175860E-07	-.90726267E-08	-.25781137E-13
.51059035E-07	.57298172E-07	-.20698406E-13	-.54019335E-08	.52857311E-07
-.69439023E-07	-.10482756E-07	.36015513E-08	-.59618938E-07	.63686977E-06
-.54634427E-06	-.37138548E-15	-.14881036E-07	-.20788290E-08	.53416876E-14
.49434274E-06	-.52138355E-06	.36084625E-15	.38245326E-02	-.95707833E-02
-.28472227E-09	.95706411E-02	.38248253E-02	-.52950837E-10	.42306378E-10
.13863650E-08	-.83012671E-08	-.31906173E-09	-.34199546E-11	.81669645E-08
-.87485007E-08	-.13865777E-08	.21238779E-14	-.17696591E+00	-.39083612E+00
-.84602464E-10	-.39083720E+00	.17696374E+00	.30775127E-10	.12256099E-08
.79443691E-09	.63405973E-08	.15032889E-07	-.80204827E-08	.24197572E-08
.15146456E-06	.22667613E-06	.27864015E+00	.12645160E-06	.20146267E-06
.74812742E+00	.23320671E-01	.71358750E-01	-.15696020E-06	-.65869035E-07
-.31119132E-06	.19170180E-07	.28954207E-06	-.78314182E-07	-.29898828E-08
.31447785E-08	.59196241E-08	-.10223336E-07	.57668967E-08	.84437859E-08
.19320351E-01	-.48725385E-08	-.12206505E-07	.11866768E+00	.30017386E-01
.48004147E-01	.21394263E-07	-.94233533E-10	-.50069943E-09	-.11013082E-06
-.39767875E-07	-.76296204E-08	.21121434E-08	.98494637E-07	-.30215091E-07
-.83151351E-09	-.86753266E-08	-.74221774E-08	-.46945470E-08	-.49700530E-01
-.27168256E+00	-.17278504E-09	-.72258733E-08	-.45094717E-08	-.82984545E-09
.26263013E-09	.59806850E-09	-.30586106E-02	-.80178997E-09	-.17350601E-08
-.65747891E-02	.56730240E-07	.96467007E-07	.10535633E-09	.30329414E-06
.66271809E-06	.35363609E-09	.17696591E+00	.39083612E+00	.84602464E-10
.34515937E-11	.11639133E-10	.11823240E-03	.78122412E-12	-.14089096E-10
-.72836582E-02	-.46789915E-08	-.15892413E-07	.65356843E-10	.31383227E-07
.10485630E-07	.42666551E-09	.22686122E-06	-.15001301E-06	.75692354E+00
.20000508E-06	-.12631014E-06	-.30143385E+00	.71358882E-01	-.23320214E-01
.38814806E-07	.48891040E-08	.41439984E-06	.18152134E-07	-.42591726E-06
.27558297E-07	.32855064E-08	.49032229E-08	-.29885627E-08	-.83085912E-07
.83112891E-08	-.55592945E-08	.12118342E+00	-.12399628E-07	.47190946E-08
-.31250391E-01	.48004340E-01	-.30017176E-01	.16597444E-08	-.50976879E-11
.19275352E-09	-.15874235E-08	-.11553120E-06	-.45920329E-07	.21718772E-07
-.11154142E-06	.12729912E-07	.22012824E-08	-.16797908E-07	.91574736E-08
-.19556552E-08	-.27168278E+00	.49698521E-01	.46204715E-10	-.11398262E-07
.86245755E-08	.84823258E-08	.60005167E-09	-.27669342E-09	-.65749091E-02
-.17209949E-08	.80376640E-09	.30587738E-02	.91711930E-07	-.55460535E-07
.51525169E-09	.66144997E-06	-.30804574E-06	-.20159786E-09	.39083720E+00
-.17696374E+00	-.30775127E-10	-.78122412E-12	.14089096E-10	.72836582E-02
-.14618963E-09	.69521649E-10	.11823684E-03	-.73228149E-08	-.29478674E-07
.22679544E-09	.44642344E-07	-.22809491E-07	.59107460E-10	-.85227134E-07
-.54382657E-06	.11012196E-05	.10593951E-05	.15030137E-05	.77536846E-05
-.47261019E-08	-.11104159E-07	.25209767E-06	.76837879E-08	.16366625E-07
.11419001E+00	.22910605E-07	.48721700E-07	.94812449E-01	-.26910936E-01
-.53138454E-01	.10396571E-06	-.37021885E-07	.17801169E-06	.12499195E-06
-.23088390E-06	.32957092E-07	.37125093E-06	-.15204283E-09	.22344016E-10
-.41855726E-07	.41887505E-02	.31354146E-01	.46431865E-07	-.44647683E-09
-.16416114E-08	.28098883E-01	.20575968E-08	.54136933E-08	-.80118470E-01
-.19954144E+00	-.51982556E+00	-.11311457E-09	.72402280E-09	.51155317E-09
-.66103844E-08	-.20012965E+00	-.34933873E+00	-.29523672E-11	-.13037445E-06
-.21701737E-06	-.12705909E-09	.65962710E-07	.12765379E-06	-.24445245E-09
.43381873E-11	.92974491E-11	.29258756E-02	.57170319E-09	.11035564E-08
.72527212E-02	-.12256099E-08	-.79443691E-09	-.63405973E-08	.46789915E-08
.15892413E-07	-.65356843E-10	.73228149E-08	.29478674E-07	-.22679544E-09
-.20205244E-11	-.39891324E-11	.87155679E-04	.84364044E-11	.86915796E-11
.68614717E-02	-.35436475E-07	-.14708492E-05	-.62332048E-06	-.10054546E-06
.52218327E-06	.39275247E-05	.82271192E-08	-.34017979E-08	.17927404E-06
-.16399263E-07	.73058140E-08	-.94493068E-01	-.48349038E-07	.22872252E-07
.11390138E+00	.53141657E-01	-.26904645E-01	.94708623E-07	.55451004E-07
.26193636E-06	-.18332552E-07	-.35360159E-06	-.28254188E-07	.38520272E-07
-.19779770E-08	.13203123E-08	-.89135235E-08	-.31354628E-01	.41849538E-02

```
-.36824273E-07  .16609482E-08 -.44578552E-09 -.79066663E-01 -.54141545E-08
 .20376560E-08 -.24921274E-01  .51984922E+00 -.19947944E+00 -.51066096E-10
 .10387562E-07 -.27226537E-08  .73095770E-08  .34936258E+00 -.20008846E+00
 .35514320E-11  .21430064E-06 -.12189418E-06  .18933107E-09 -.13611625E-06
 .63215067E-07 -.27202374E-09 -.76083731E-11 -.16981023E-11 -.72526267E-02
-.10976139E-08  .57328140E-09  .29238966E-02 -.15032889E-07  .80204827E-08
-.24197572E-08 -.31383227E-07 -.10485630E-07 -.42666551E-09 -.44642344E-07
 .22809491E-07 -.59107460E-10 -.84364044E-11 -.86915796E-11 -.68614717E-02
-.10375733E-09  .53480837E-10  .87160403E-04
kdyic1
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00
rvtor1
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00

(and more)
```

A.3 Concept 2B Definitions and TREETOPS files

Sensor Definitions
Actuator Definitions
Interconnect Definitions
TREETOPS files:
Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx

Table A.3.1 Sensor Definitions (Concept 2A and 2B)

Global Sensor Output No.	TREETOPS Sensor Designation	Local Sensor Output No.	Sensor Mount Loc.	Type	used	DOF
RP1	SE 1	1	B2-N2	Earth Target (ET) (LOS Along X^{B2})		Pitch (Y^{B2}) Error – Overall System
RP2	SE 1	2	B2-N2			Yaw (Z^{B2}) Error – Overall System
RP3	SE 2	1	B2-N2	Star Tracker (ST) (LOS Along Z^{B2})		Roll (X^{B2}) Error – Overall System
RP4	SE 2	2	B2-N2			Not used in control (Pitch (Y^{B2}) Error)
RP5	SE 2	3	B2-N2			Not used in control (Validity Flag on(1) off(0))
RP6	SE 3	1	B3-N2	LOS Sensor (L) (LOS Along $-Y^{I}$) (Negative Polar Axis) see .los file		Roll (X^{B3}) Error – Upper Clamshell
RP7	SE 3	2	B3-N2			Pitch (Y^{B3}) Error – Upper Clamshell
RP8	SE 3	3	B3-N2			Not used in control, Yaw (Z^{B3}) Error – Upper Clamshell
RP9	SE 3	4	B3-N2			Not used in control
RP10	SE 3	5	B3-N2			Not used in control
RP11	SE 3	6	B3-N2			Not used in control
RP12	SE 3	7	B3-N2			Not used in control
RP13	SE 4	1	B4-N2	LOS Sensor (L) (LOS Along $+Y^{I}$) (Positive Polar Axis) see .los file		Roll (X^{B4}) Error – Lower Clamshell
RP14	SE 4	2	B4-N2			Pitch (Y^{B4}) Error – Lower Clamshell
RP15	SE 4	3	B4-N2			Not used in control, Yaw (Z^{B4}) Error – Lower Clamshell
RP16	SE 4	4	B4-N2			Not used in control
RP 17	SE 4	5	B4-N2			Not used in control
RP 18	SE 4	6	B4-N2			Not used in control
RP 19	SE 4	7	B4-N2			Not used in control
RP 20	SE 5	1	B2-N5	Star Tracker (ST) (LOS Along $-X^{B2}$) (Towards Sun)		Not used in control (Yaw (Z^{B2}) Error
RP 21	SE 5	2	B2-N5			Not used in control (Pitch (Y^{B2}) Error)
RP 22	SE 5	3	B2-N5			Validity Flag on(1) off(0) Used for Rad Pres Disturb
RP 23	SE 6	1	B2-N2	3 Axis Accelerometer (A3) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B2})
RP 24	SE 6	2	B2-N2			Not used in control, For Output Only, ACCEL (Y^{B2})
RP 25	SE 6	3	B2-N2			Not used in control, For Output Only, ACCEL (Z^{B2})

Table A.3.2 Actuator Definitions (Concept 2A and 2B)

Global Actuator Input No.	TREETOPS Actuator Designation	Sensor Mount Loc.	Type	DOF
UP 1	AC 1	B2-N2	Moment Actuator (MO)*	Pitch (Y^{B2}) Ext. Torque – Overall System
UP 2	AC 2	B2-N2	Moment Actuator (MO)*	Yaw (Z^{B2}) Ext. Torque – Overall System
UP 3	AC 3	B2-N2	Moment Actuator (MO)*	Roll (X^{B2}) Ext. Torque – Overall System
UP 4	AC 4	B3-N2	Moment Actuator (MO)*	Roll (X^{B3}) Ext. Torque – Upper Clamshell
UP 5	AC 5	B3-N2	Moment Actuator (MO)*	Pitch (Y^{B3}) Ext. Torque – Upper Clamshell
UP 6	AC 6	B4-N2	Moment Actuator (MO)*	Roll (X^{B4}) Ext. Torque – Lower Clamshell
UP 7	AC 7	B4-N2	Moment Actuator (MO)*	Pitch (Y^{B4}) Ext. Torque – Lower Clamshell
UP 8	AC 8	B2-N5	Reaction Jet (J) Radiation Pressure Disturbance	$-X^{B2}$ Force at Central Body Transmitter

Notes:
* Moment Actuator (MO) in TREETOPS is an External Moment applied to a Body (Reacts against Space)
Used in Control

Table A.3.3:
Interconnect Data and Significant Parameters for TREETOPS Continuous Matrix (CM) Controller (Concept 2A and 2B)

Interconnect Data						Significant Parameters in Continuous Matrix (CM) Controller in .lin file xdot = Ax + Bu y = Cx + Du			
Inter-connect	Description	S C C A	S No. C No. C No. A No.	S Out No. C In No. C Out No. A In No.	Gain N-m or N	Subset of A Matrix	Subset of B Matrix	Subset of C Matrix ω^2 $2\zeta\omega$	Subset of D Matrix
IC 1	Pitch (Y^{B2}) of Overall System	S	1	1	4.41E13	0. 1.	0	.000025 .007	0
		C	1	1					
IC 2		C	1	1	1.0	-1. -1.4	1		
		A	1	1					
IC 3	Yaw (Z^{B2}) of Overall System	S	1	2	1.67E12	0. 1.	0	.000025 .007	0
		C	1	2					
IC 4		C	1	2	1.0	-1. -1.4	1		
		A	2	1					
IC 5	Roll (X^{B2}) of Overall System	S	2	1	4.31E13	0. 1.	0	.000025 .007	0
		C	1	3					
IC 6		C	1	3	1.0	-1. -1.4	1		
		A	3	1					
IC 7	Roll (X^{B3}) of Upper Clamshell	S	3	1	1.7E12	0. 1.	0	.0001 .014	0
		C	1	4					
IC 8		C	1	4	1.0	-1. -1.4	1		
		A	4	1					
IC 9	Pitch (Y^{B3}) of Upper Clamshell	S	3	2	1.7E12	0. 1.	0	.0001 .014	0
		C	1	5					
IC 10		C	1	5	1.0	-1. -1.4	1		
		A	5	1					
IC 11	Roll (X^{B4}) of Lower Clamshell	S	4	1	1.7E12	0. 1.	0	.0001 .014	0
		C	1	6					
IC 12		C	1	6	1.0	-1. -1.4	1		
		A	6	1					
IC 13	Pitch (Y^{B4}) of Lower Clamshell	S	4	2	1.7E12	0. 1.	0	.0001 .014	0
		C	1	7					
IC 14		C	1	7	1.0	-1. -1.4	1		
		A	7	1					
IC 15	-X^{B2} of Radiation Pres Disturb	S	5	3	7.0				
		A	8	1					

isc3_flex_sol.int (Concept 2B) Summer Solstice

```
TREETOPS REV 10P2  4/10/00

          SIM CONTROL

 1 SI   0 Title                                                    ISC MODEL, THIRD VERSION
 2 SI   0 Simulation stop time                                     100000
 3 SI   0 Plot data interval                                       20
 4 SI   0 Integration type (R,S,U, OR V)                           R
 5 SI   0 Step size (sec)                                          .1
 6 SI   0 Sandia ODE solver absolute and relative error
 7 SI   0 RK78 ODE solver absolute error and first step size
 8 SI   0 Linearization option  (L,Z or N)                         N
 9 SI   0 Restart option           (Y/N)                           N
10 SI   0 Contact force computation option      (Y/N)              Y
11 SI   0 Constraint force computation option  (Y/N)               N
12 SI   0 Small angle speedup option (All,Bypass,First,Nth)        A
13 SI   0 Mass matrix speedup option (All,Bypass,First,Nth)        A
14 SI   0 Non-Linear  speedup option (All,Bypass,First,Nth)        A
15 SI   0 Constraint  speedup option (All,Bypass,First,Nth)        A
16 SI   0 Constraint stabilization option  (Y/N)                   N
17 SI   0 Stabilization epsilon



          GENGRAV

18 GG   5 Gravity, earth sphere/nonsphere/user (S/N/U)?            N
19 GG   1 Input gravity constants:  GME, ERAD, EMASS
20 GG   1 Spherical or Nonspherical (S/N)?
21 GG   1 Gravity Potential Harmonics J2,J3,J4
22 GG   5 English (ft-slug-s) or metric (m-kg-s)     (E/M)?        M
23 GG   5 Day, Month, Year,                                        21 6 2020
24 GG   5 GMT @ sim time 0 (minutes past midnight,                 0
25 GG   5 Solar Pressure forces Y/N?                               Y
26 GG   5 Input new data for aero model? (Y/N)                     N
27 GG   1   Solar flux F10 for aero model
28 GG   1   Solar flux, 81 day average F10B
29 GG   1   Geomagnetic index, GEAP


          BODY

30 BO   1 Body ID number                                           1
31 BO   1 Type (Rigid,Flexible,NASTRAN)                            F
32 BO   1 Number of modes                                          24
33 BO   1 Modal calculation option (0, 1 or 2)                     2
34 BO   1 Foreshortening option (Y/N)
35 BO   1 Model reduction method (NO,MS,MC,CC,QM,CV)
36 BO   1 NASTRAN data file FORTRAN unit number (40 - 60)
37 BO   1 Number of augmented nodes (0 if none)
38 BO   1 Damping matrix option (NS,CD,HL,SD)
39 BO   1 Constant damping ratio
40 BO   1 Low frequency, High frequency ratios
41 BO   1 Mode ID number, damping ratio
42 BO   1 Conversion factors: Length,Mass,Force
43 BO   1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
44 BO   1 Moments of inertia (kg-m2) Ixx,Iyy,Izz                   6.2852173E11 6.2852173E11
6.7057352E8
45 BO   1 Products of inertia (kg-m2) Ixy,Ixz,Iyz                  0 0 0
46 BO   1 Mass (kg)                                                1.6168633E5
47 BO   1 Number of Nodes                                          4
48 BO   1 Node ID, Node coord. (meters) x,y,z                      1 0 0 0
49 BO   1 Node ID, Node coord. (meters) x,y,z                      2 0 0 0
50 BO   1 Node ID, Node coord. (meters) x,y,z                      3 0 0 3188.8
51 BO   1 Node ID, Node coord. (meters) x,y,z                      4 0 0 -3188.8
52 BO   1 Node ID, Node structual joint ID
```

```
 53 BO   2 Body ID number                                          2
 54 BO   2 Type (Rigid,Flexible,NASTRAN)                           R
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz              .8543E12 1.5601E12
1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 69 BO   2 Mass (kg)                                           12666300
 70 BO   2 Number of Nodes                                     5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                 1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                 3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                 4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                 5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                      3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                       R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 93 BO   3 Mass (kg)                                           2046600
 94 BO   3 Number of Nodes                                     2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                 1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                      4
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                       R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
110 BO   4 Conversion factors: Length,Mass,Force
111 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
112 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1.7E12 1.7E12 3.4E12
113 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
114 BO   4 Mass (kg)                                           2046600
115 BO   4 Number of Nodes                                     2
116 BO   4 Node ID, Node coord. (meters) x,y,z                 1 0 0 0
117 BO   4 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
118 BO   4 Node ID, Node structual joint ID
```

HINGE

119	HI	1	Hinge ID number	1
120	HI	1	Inboard body ID, Outboard body ID	0 1
121	HI	1	"p" node ID, "q" node ID	0 2
122	HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123	HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124	HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125	HI	1	L2 unit vector in inboard body coord. x,y,z	
126	HI	1	L2 unit vector in outboard body coord. x,y,z	
127	HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128	HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129	HI	1	Initial rotation angles (deg)	-90 0 90
130	HI	1	Initial rotation rates (deg/sec)	0 0 0.00417807
131	HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132	HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133	HI	1	Null torque angles (deg)	0 0 0
134	HI	1	Number of translation DOFs	3
135	HI	1	First translation unit vector g1	1 0 0
136	HI	1	Second translation unit vector g2	0 1 0
137	HI	1	Third translation unit vector g3	0 0 1
138	HI	1	Initial translation (meters)	0 0 42163421
139	HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140	HI	1	Translation stiffness (newtons/meters)	0 0 0
141	HI	1	Translation damping (newtons/meter/sec)	0 0 0
142	HI	1	Null force translations	0 0 0
143	HI	2	Hinge ID number	2
144	HI	2	Inboard body ID, Outboard body ID	1 2
145	HI	2	"p" node ID, "q" node ID	2 2
146	HI	2	Number of rotation DOFs	0
147	HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148	HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149	HI	2	L2 unit vector in inboard body coord. x,y,z	
150	HI	2	L2 unit vector in outboard body coord. x,y,z	
151	HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152	HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153	HI	2	Initial rotation angles (deg)	0 0 0
154	HI	2	Initial rotation rates (deg/sec)	
155	HI	2	Rotation stiffness (newton-meters/rad)	
156	HI	2	Rotation damping (newton-meters/rad/sec)	
157	HI	2	Null torque angles (deg)	
158	HI	2	Number of translation DOFs	0
159	HI	2	First translation unit vector g1	1 0 0
160	HI	2	Second translation unit vector g2	0 1 0
161	HI	2	Third translation unit vector g3	0 0 1
162	HI	2	Initial translation (meters)	0 0 0
163	HI	2	Initial translation velocity (meters/sec)	
164	HI	2	Translation stiffness (newtons/meters)	
165	HI	2	Translation damping (newtons/meter/sec)	
166	HI	2	Null force translations	
167	HI	3	Hinge ID number	3
168	HI	3	Inboard body ID, Outboard body ID	1 3
169	HI	3	"p" node ID, "q" node ID	3 2
170	HI	3	Number of rotation DOFs	2
171	HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172	HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173	HI	3	L2 unit vector in inboard body coord. x,y,z	1 0 0
174	HI	3	L2 unit vector in outboard body coord. x,y,z	1 0 0
175	HI	3	L3 unit vector in inboard body coord. x,y,z	
176	HI	3	L3 unit vector in outboard body coord. x,y,z	
177	HI	3	Initial rotation angles (deg)	0. 123.25 0.
178	HI	3	Initial rotation rates (deg/sec)	-.004178 0
179	HI	3	Rotation stiffness (newton-meters/rad)	0 0
180	HI	3	Rotation damping (newton-meters/rad/sec)	0 0
181	HI	3	Null torque angles (deg)	0 0
182	HI	3	Number of translation DOFs	0
183	HI	3	First translation unit vector g1	1 0 0
184	HI	3	Second translation unit vector g2	0 1 0

```
185 HI   3 Third translation unit vector   g3                    0 0 1
186 HI   3 Initial translation (meters)                           0 0 0
187 HI   3 Initial translation velocity (meters/sec)
188 HI   3 Translation stiffness (newtons/meters)
189 HI   3 Translation damping (newtons/meter/sec)
190 HI   3 Null force translations

191 HI   4 Hinge ID number                                        4
192 HI   4 Inboard body ID, Outboard body ID                      1 4
193 HI   4 "p" node ID, "q" node ID                               4 2
194 HI   4  Number of rotation DOFs                               2
195 HI   4 L1 unit vector in inboard body coord. x,y,z            0 0 1
196 HI   4 L1 unit vector in outboard body coord. x,y,z           0 0 1
197 HI   4 L2 unit vector in inboard body coord. x,y,z            1 0 0
198 HI   4 L2 unit vector in outboard body coord. x,y,z           1 0 0
199 HI   4 L3 unit vector in inboard body coord. x,y,z
200 HI   4 L3 unit vector in outboard body coord. x,y,z
201 HI   4 Initial rotation angles (deg)                          0. 33.25 0.
202 HI   4 Initial rotation rates (deg/sec)                       -.004178 0
203 HI   4 Rotation stiffness (newton-meters/rad)                 0 0
204 HI   4 Rotation damping (newton-meters/rad/sec)               0 0
205 HI   4 Null torque angles (deg)                               0 0
206 HI   4 Number of translation DOFs                             0
207 HI   4 First translation unit vector   g1                     1 0 0
208 HI   4 Second translation unit vector  g2                     0 1 0
209 HI   4 Third translation unit vector   g3                     0 0 1
210 HI   4 Initial translation (meters)                           0 0 0
211 HI   4 Initial translation velocity (meters/sec)
212 HI   4 Translation stiffness (newtons/meters)
213 HI   4 Translation damping (newtons/meter/sec)
214 HI   4 Null force translations

           SENSOR

215 SE   1 Sensor ID number                                       1
216 SE   1 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)     ET
217 SE   1 Mounting point body ID, Mounting point node ID         2 2
218 SE   1 Second mounting point body ID, Second node ID
219 SE   1 Input axis unit vector (IA) x,y,z
220 SE   1 Mounting point Hinge index, Axis index
221 SE   1 First focal plane unit vector  (Fp1) x,y,z             0 0 -1
222 SE   1 Second focal plane unit vector (Fp2) x,y,z             0 1 0
223 SE   1 Sun/Star unit vector (Us) x,y,z
224 SE   1 Velocity Aberration Option (Y/N)
225 SE   1 Euler Angle Sequence (1-6)
226 SE   1 CMG ID number and Gimbal number
227 SE   1 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])      6378000 0 0 4.178074D-3

228 SE   2 Sensor ID number                                       2
229 SE   2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)     ST
230 SE   2 Mounting point body ID, Mounting point node ID         2 2
231 SE   2 Second mounting point body ID, Second node ID
232 SE   2 Input axis unit vector (IA) x,y,z
233 SE   2 Mounting point Hinge index, Axis index
234 SE   2 First focal plane unit vector  (Fp1) x,y,z             0 -1 0
235 SE   2 Second focal plane unit vector (Fp2) x,y,z             1 0 0
236 SE   2 Sun/Star unit vector (Us) x,y,z                        0 1 0
237 SE   2 Velocity Aberration Option (Y/N)                       N
238 SE   2 Euler Angle Sequence (1-6)
239 SE   2 CMG ID number and Gimbal number
240 SE   2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE   3 Sensor ID number                                       3
242 SE   3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)     L
243 SE   3 Mounting point body ID, Mounting point node ID         3 2
244 SE   3 Second mounting point body ID, Second node ID
245 SE   3 Input axis unit vector (IA) x,y,z                      1 2 3
246 SE   3 Mounting point Hinge index, Axis index
247 SE   3 First focal plane unit vector  (Fp1) x,y,z
248 SE   3 Second focal plane unit vector (Fp2) x,y,z
```

249	SE	3	Sun/Star unit vector (Us) x,y,z	
250	SE	3	Velocity Aberration Option (Y/N)	
251	SE	3	Euler Angle Sequence (1-6)	
252	SE	3	CMG ID number and Gimbal number	
253	SE	3	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
254	SE	4	Sensor ID number	4
255	SE	4	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	L
256	SE	4	Mounting point body ID, Mounting point node ID	4 2
257	SE	4	Second mounting point body ID, Second node ID	
258	SE	4	Input axis unit vector (IA) x,y,z	3 2 1
259	SE	4	Mounting point Hinge index, Axis index	
260	SE	4	First focal plane unit vector (Fp1) x,y,z	
261	SE	4	Second focal plane unit vector (Fp2) x,y,z	
262	SE	4	Sun/Star unit vector (Us) x,y,z	
263	SE	4	Velocity Aberration Option (Y/N)	
264	SE	4	Euler Angle Sequence (1-6)	
265	SE	4	CMG ID number and Gimbal number	
266	SE	4	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
267	SE	5	Sensor ID number	5
268	SE	5	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
269	SE	5	Mounting point body ID, Mounting point node ID	2 5
270	SE	5	Second mounting point body ID, Second node ID	
271	SE	5	Input axis unit vector (IA) x,y,z	
272	SE	5	Mounting point Hinge index, Axis index	
273	SE	5	First focal plane unit vector (Fp1) x,y,z	0 0 1
274	SE	5	Second focal plane unit vector (Fp2) x,y,z	0 -1 0
275	SE	5	Sun/Star unit vector (Us) x,y,z	0 0 0
276	SE	5	Velocity Aberration Option (Y/N)	N
277	SE	5	Euler Angle Sequence (1-6)	
278	SE	5	CMG ID number and Gimbal number	
279	SE	5	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
280	SE	6	Sensor ID number	6
281	SE	6	Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	A3
282	SE	6	Mounting point body ID, Mounting point node ID	2 2
283	SE	6	Second mounting point body ID, Second node ID	
284	SE	6	Input axis unit vector (IA) x,y,z	
285	SE	6	Mounting point Hinge index, Axis index	
286	SE	6	First focal plane unit vector (Fp1) x,y,z	
287	SE	6	Second focal plane unit vector (Fp2) x,y,z	
288	SE	6	Sun/Star unit vector (Us) x,y,z	
289	SE	6	Velocity Aberration Option (Y/N)	
290	SE	6	Euler Angle Sequence (1-6)	
291	SE	6	CMG ID number and Gimbal number	
292	SE	6	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	

ACTR

293	AC	1	Actuator ID number	1
294	AC	1	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
295	AC	1	Actuator location; Node or Hinge (N or H)	
296	AC	1	Mounting point body ID number, node ID number	2 2
297	AC	1	Second mounting point body ID, second node ID	
298	AC	1	Output axis unit vector x,y,z	0 1 0
299	AC	1	Mounting point Hinge index, Axis index	
300	AC	1	Rotor spin axis unit vector x,y,z	
301	AC	1	Initial rotor momentum, H	
302	AC	1	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
303	AC	1	Outer gimbal axis unit vector x,y,z	
304	AC	1	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
305	AC	1	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
306	AC	1	Inner gimbal axis unit vector x,y,z	
307	AC	1	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
308	AC	1	Initial length and rate, y(to) and ydot(to)	
309	AC	1	Constants; K1 or wo, n or zeta, Kg, Jm	
310	AC	1	Non-linearities; TLim, Tco, Dz	
311	AC	2	Actuator ID number	2

312	AC	2	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
313	AC	2	Actuator location; Node or Hinge (N or H)	
314	AC	2	Mounting point body ID number, node ID number	2 2
315	AC	2	Second mounting point body ID, second node ID	
316	AC	2	Output axis unit vector x,y,z	0 0 1
317	AC	2	Mounting point Hinge index, Axis index	
318	AC	2	Rotor spin axis unit vector x,y,z	
319	AC	2	Initial rotor momentum, H	
320	AC	2	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
321	AC	2	Outer gimbal axis unit vector x,y,z	
322	AC	2	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
323	AC	2	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
324	AC	2	Inner gimbal axis unit vector x,y,z	
325	AC	2	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
326	AC	2	Initial length and rate, y(to) and ydot(to)	
327	AC	2	Constants; K1 or wo, n or zeta, Kg, Jm	
328	AC	2	Non-linearities; TLim, Tco, Dz	
329	AC	3	Actuator ID number	3
330	AC	3	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
331	AC	3	Actuator location; Node or Hinge (N or H)	
332	AC	3	Mounting point body ID number, node ID number	2 2
333	AC	3	Second mounting point body ID, second node ID	
334	AC	3	Output axis unit vector x,y,z	1 0 0
335	AC	3	Mounting point Hinge index, Axis index	
336	AC	3	Rotor spin axis unit vector x,y,z	
337	AC	3	Initial rotor momentum, H	
338	AC	3	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
339	AC	3	Outer gimbal axis unit vector x,y,z	
340	AC	3	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
341	AC	3	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
342	AC	3	Inner gimbal axis unit vector x,y,z	
343	AC	3	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
344	AC	3	Initial length and rate, y(to) and ydot(to)	
345	AC	3	Constants; K1 or wo, n or zeta, Kg, Jm	
346	AC	3	Non-linearities; TLim, Tco, Dz	
347	AC	4	Actuator ID number	4
348	AC	4	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
349	AC	4	Actuator location; Node or Hinge (N or H)	
350	AC	4	Mounting point body ID number, node ID number	3 2
351	AC	4	Second mounting point body ID, second node ID	
352	AC	4	Output axis unit vector x,y,z	1 0 0
353	AC	4	Mounting point Hinge index, Axis index	
354	AC	4	Rotor spin axis unit vector x,y,z	
355	AC	4	Initial rotor momentum, H	
356	AC	4	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
357	AC	4	Outer gimbal axis unit vector x,y,z	
358	AC	4	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
359	AC	4	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
360	AC	4	Inner gimbal axis unit vector x,y,z	
361	AC	4	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
362	AC	4	Initial length and rate, y(to) and ydot(to)	
363	AC	4	Constants; K1 or wo, n or zeta, Kg, Jm	
364	AC	4	Non-linearities; TLim, Tco, Dz	
365	AC	5	Actuator ID number	5
366	AC	5	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
367	AC	5	Actuator location; Node or Hinge (N or H)	
368	AC	5	Mounting point body ID number, node ID number	3 2
369	AC	5	Second mounting point body ID, second node ID	
370	AC	5	Output axis unit vector x,y,z	0 1 0
371	AC	5	Mounting point Hinge index, Axis index	
372	AC	5	Rotor spin axis unit vector x,y,z	
373	AC	5	Initial rotor momentum, H	
374	AC	5	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
375	AC	5	Outer gimbal axis unit vector x,y,z	
376	AC	5	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
377	AC	5	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
378	AC	5	Inner gimbal axis unit vector x,y,z	
379	AC	5	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	

```
380 AC   5 Initial length and rate, y(to) and ydot(to)
381 AC   5 Constants; K1 or wo, n or zeta, Kg, Jm
382 AC   5 Non-linearities; TLim, Tco, Dz

383 AC   6 Actuator ID number                                    6
384 AC   6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                   MO
385 AC   6 Actuator location; Node or Hinge (N or H)
386 AC   6 Mounting point body ID number, node ID number         4 2
387 AC   6 Second mounting point body ID, second node ID
388 AC   6 Output axis unit vector x,y,z                         1 0 0
389 AC   6 Mounting point Hinge index, Axis index
390 AC   6 Rotor spin axis unit vector x,y,z
391 AC   6 Initial rotor momentum, H
392 AC   6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
393 AC   6 Outer gimbal axis unit vector x,y,z
394 AC   6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
395 AC   6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
396 AC   6 Inner gimbal axis unit vector x,y,z
397 AC   6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
398 AC   6 Initial length and rate, y(to) and ydot(to)
399 AC   6 Constants; K1 or wo, n or zeta, Kg, Jm
400 AC   6 Non-linearities; TLim, Tco, Dz

401 AC   7 Actuator ID number                                    7
402 AC   7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                   MO
403 AC   7 Actuator location; Node or Hinge (N or H)
404 AC   7 Mounting point body ID number, node ID number         4 2
405 AC   7 Second mounting point body ID, second node ID
406 AC   7 Output axis unit vector x,y,z                         0 1 0
407 AC   7 Mounting point Hinge index, Axis index
408 AC   7 Rotor spin axis unit vector x,y,z
409 AC   7 Initial rotor momentum, H
410 AC   7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
411 AC   7 Outer gimbal axis unit vector x,y,z
412 AC   7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
413 AC   7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
414 AC   7 Inner gimbal axis unit vector x,y,z
415 AC   7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
416 AC   7 Initial length and rate, y(to) and ydot(to)
417 AC   7 Constants; K1 or wo, n or zeta, Kg, Jm
418 AC   7 Non-linearities; TLim, Tco, Dz

419 AC   8 Actuator ID number                                    8
420 AC   8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                   J
421 AC   8 Actuator location; Node or Hinge (N or H)
422 AC   8 Mounting point body ID number, node ID number         2 5
423 AC   8 Second mounting point body ID, second node ID
424 AC   8 Output axis unit vector x,y,z                         -1 0 0
425 AC   8 Mounting point Hinge index, Axis index
426 AC   8 Rotor spin axis unit vector x,y,z
427 AC   8 Initial rotor momentum, H
428 AC   8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
429 AC   8 Outer gimbal axis unit vector x,y,z
430 AC   8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
431 AC   8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
432 AC   8 Inner gimbal axis unit vector x,y,z
433 AC   8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
434 AC   8 Initial length and rate, y(to) and ydot(to)
435 AC   8 Constants; K1 or wo, n or zeta, Kg, Jm
436 AC   8 Non-linearities; TLim, Tco, Dz

         CONTROLLER

437 CO   1 Controller ID number                                  1
438 CO   1 Controller type (CB,CM,DB,DM,UC,UD)                   CM
439 CO   1 Sample time (sec)
440 CO   1 Number of inputs, Number of outputs                   7 7
441 CO   1 Number of states
442 CO   1 Output No., Input type (I,S,T), Input ID, Gain
```

INTERCONNECT

443	IN	1 Interconnect ID number	1
444	IN	1 Source type(S,C, or F),Source ID,Source row #	S 1 1
445	IN	1 Destination type(A or C),Dest ID,Dest row #	C 1 1
446	IN	1 Gain	4.41E13
447	IN	2 Interconnect ID number	2
448	IN	2 Source type(S,C, or F),Source ID,Source row #	C 1 1
449	IN	2 Destination type(A or C),Dest ID,Dest row #	A 1 1
450	IN	2 Gain	1.
451	IN	3 Interconnect ID number	3
452	IN	3 Source type(S,C, or F),Source ID,Source row #	S 1 2
453	IN	3 Destination type(A or C),Dest ID,Dest row #	C 1 2
454	IN	3 Gain	1.67E12
455	IN	4 Interconnect ID number	4
456	IN	4 Source type(S,C, or F),Source ID,Source row #	C 1 2
457	IN	4 Destination type(A or C),Dest ID,Dest row #	A 2 1
458	IN	4 Gain	1
459	IN	5 Interconnect ID number	5
460	IN	5 Source type(S,C, or F),Source ID,Source row #	S 2 1
461	IN	5 Destination type(A or C),Dest ID,Dest row #	C 1 3
462	IN	5 Gain	4.31E13
463	IN	6 Interconnect ID number	6
464	IN	6 Source type(S,C, or F),Source ID,Source row #	C 1 3
465	IN	6 Destination type(A or C),Dest ID,Dest row #	A 3 1
466	IN	6 Gain	1
467	IN	7 Interconnect ID number	7
468	IN	7 Source type(S,C, or F),Source ID,Source row #	S 3 1
469	IN	7 Destination type(A or C),Dest ID,Dest row #	C 1 4
470	IN	7 Gain	1.7E12
471	IN	8 Interconnect ID number	8
472	IN	8 Source type(S,C, or F),Source ID,Source row #	C 1 4
473	IN	8 Destination type(A or C),Dest ID,Dest row #	A 4 1
474	IN	8 Gain	1
475	IN	9 Interconnect ID number	9
476	IN	9 Source type(S,C, or F),Source ID,Source row #	S 3 2
477	IN	9 Destination type(A or C),Dest ID,Dest row #	C 1 5
478	IN	9 Gain	1.7E12
479	IN	10 Interconnect ID number	10
480	IN	10 Source type(S,C, or F),Source ID,Source row #	C 1 5
481	IN	10 Destination type(A or C),Dest ID,Dest row #	A 5 1
482	IN	10 Gain	1
483	IN	11 Interconnect ID number	11
484	IN	11 Source type(S,C, or F),Source ID,Source row #	S 4 1
485	IN	11 Destination type(A or C),Dest ID,Dest row #	C 1 6
486	IN	11 Gain	1.7E12
487	IN	12 Interconnect ID number	12
488	IN	12 Source type(S,C, or F),Source ID,Source row #	C 1 6
489	IN	12 Destination type(A or C),Dest ID,Dest row #	A 6 1
490	IN	12 Gain	1
491	IN	13 Interconnect ID number	13
492	IN	13 Source type(S,C, or F),Source ID,Source row #	S 4 2
493	IN	13 Destination type(A or C),Dest ID,Dest row #	C 1 7
494	IN	13 Gain	1.7E12
495	IN	14 Interconnect ID number	14
496	IN	14 Source type(S,C, or F),Source ID,Source row #	C 1 7
497	IN	14 Destination type(A or C),Dest ID,Dest row #	A 7 1

```
498 IN  14 Gain                                                    1

499 IN  15 Interconnect ID number                                  15
500 IN  15 Source type(S,C, or F),Source ID,Source row #          S 5 3
501 IN  15 Destination type(A or C),Dest ID,Dest row #            A 8 1
502 IN  15 Gain                                                    7.0
```

isc3_flex_sol.lin (Concept 2B) Summer Solstice

```
* Controller for integrated symmetrical concentrator
system CONT1 14,7,7,0,0,0.0
*A
0 1 0 0 0 0 0 0 0 0 0 0 0 0
-1 -1.4 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 -1 -1.4 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 -1 -1.4 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 -1 -1.4 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 -1 -1.4 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 0 0 0 -1 -1.4 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0 0 0 0 0 -1 -1.4
*B
0 0 0 0 0 0 0
1 0 0 0 0 0 0
0 0 0 0 0 0 0
0 1 0 0 0 0 0
0 0 0 0 0 0 0
0 0 1 0 0 0 0
0 0 0 0 0 0 0
0 0 0 1 0 0 0
0 0 0 0 0 0 0
0 0 0 0 1 0 0
0 0 0 0 0 0 0
0 0 0 0 0 1 0
0 0 0 0 0 0 0
0 0 0 0 0 0 1

*C
.000025 .007  0 0 0 0 0 0 0 0 0 0 0 0
0 0 .000025 .007 0 0 0 0 0 0 0 0 0 0
0 0 0 0 .000025 .007 0 0 0 0 0 0 0 0
0 0 0 0 0 0 .0001 .014  0 0 0 0 0 0
0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0
0 0 0 0 0 0 0 0 0 0 .0001 .014  0 0
0 0 0 0 0 0 0 0 0 0 0 0 .0001 .014
*D
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
0 0 0 0 0 0 0
*H
*M
```

los.dat (Concept 2B) Summer Solstice

```
3,              ! Sensor number of 1st FGS (clamshell) sensor
0.d0,0.d0,0.d0,         ! Defaults to sun as a target for zero input vector
0.d0, -1.d0,0.d0,       ! Target star along negative polar axis
0.d0,-1.d0,0.d0,        ! Focal plane vector 1
1.d0,0.d0,0.d0,         ! Focal plane vector 2
1.d0,0.d0,0.d0,         ! Focal plane vector 3

 4,             ! Sensor number of 2nd FGS (clamshell) sensor
0.d0,0.d0,0.d0,         ! Defaults to sun as a target for zero input vector
0.d0, 1.d0,0.d0,        ! Target star along positive polar axis
0.d0,-1.d0,0.d0,        ! Focal plane vector 1
1.d0,0.d0,0.d0,         ! Focal plane vector 2
-1.d0,0.d0,0.d0,        ! Focal plane vector 3
```

solar_pressure.dat (Concept 2B) Summer Solstice

```
22, 'm',        ! number of panels, units English or Metric ***Updated 11/15/00***
1,2,638000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,-7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,-7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0, 0.1736d0,0.d0,0.9848d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0, -0.1736d0,1.d0,-0.9848d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0, 0.1736d0,0.d0,-0.9848d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0, -0.1736d0,-1.d0,0.9848d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0, 1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,     ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,     ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
```

isc3_flex_sol.flx (Concept 2B) Summer Solstice (An Excerpt)

```
flag, revision number
XXXXXX        1
  body id
      1
  modes, nodes, modal options
      24       4       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
       0       0       0       0       0       0       0       0
  phi_t for node #          2
  .31310941E-02 -.16357954E-03  .19158607E-08  .68659216E-04  .31346273E-02
  .14949358E-08 -.33409338E-09 -.17910070E-08 -.62130721E-04  .10048928E-08
  .74260327E-10 -.81693812E-09  .66744219E-10 -.57300403E-09  .56292416E-10
 -.31109642E-09  .51999889E-08  .41569313E-10  .36697769E-02  .69502051E-03
  .85567197E-10 -.10557893E-02  .35826871E-02  .65924560E-10  .61553749E-10
  .11085623E-08 -.67301328E-05  .49549244E-10 -.49437998E-08 -.60865848E-11
  .10484816E-08  .39239830E-10 -.17858973E-09  .46440350E-10  .23145265E-09
  .76239104E-11 -.98486197E-09 -.52382674E-09  .30708566E-12  .12143532E-10
 -.10722701E-09  .94529479E-03  .17735129E-08  .15323995E-09  .13868812E-12
 -.13390485E-02 -.55272105E-04 -.82202021E-12  .55317399E-04 -.13390483E-02
  .27552836E-11  .29149021E-10 -.27567962E-12 -.44865972E-10  .48584658E-11
  .10595799E-10 -.31919479E-08 -.19937738E-10  .14255509E-09 -.23770452E-02
 -.45933446E-03 -.19673179E-04  .63985161E-12 -.19675549E-04  .45933391E-03
 -.74265281E-12 -.34874105E-11 -.12587102E-11  .59687765E-09 -.12099360E-11
 -.69004494E-11  .19524343E-08
  phi_t prime for node #          2
  .17177767E-11 -.22808543E-11 -.45683561E-10  .19817016E-10  .56718933E-12
  .31514104E-09  .17463000E-11 -.27057756E-13 -.60467460E-12  .11400599E-06
 -.42543750E-05 -.11919737E-10  .42546793E-05  .10153760E-06 -.34352434E-10
  .41859459E-11 -.37080794E-11  .59234151E-04  .45504345E-11 -.70844966E-12
  .15588470E-10  .13593377E-10  .68741697E-12  .87795145E-10 -.28497036E-11
  .31909564E-13 -.69421743E-15  .38765922E-11 -.41335440E-11 -.44983453E-04
  .22473012E-05 -.13022411E-04  .41075666E-11 -.13101519E-04 -.17274113E-05
 -.98017672E-11 -.14778531E-12 -.42275125E-13 -.96071643E-06 -.25440820E-11
  .54200130E-11  .41425181E-12 -.51084189E-13  .98880082E-15  .14899414E-06
 -.49351318E-14  .15066380E-14 -.42969795E-10 -.54223125E-14  .27635772E-15
 -.79851673E-11  .23444071E-06 -.40722409E-05 -.13017710E-13  .40722809E-05
  .23382333E-06  .64327760E-12 -.80030821E-11  .19070818E-11  .27557384E-13
  .67193209E-14  .15459451E-13  .15489036E-10  .28188639E-13  .15021236E-15
  .22611633E-11 -.61243211E-07  .17482812E-05  .30019490E-13 -.17482739E-05
 -.61449314E-07 -.27684414E-12
  phi_t for node #          3
 -.42404714E-02  .49480955E-03  .19835813E-08 -.36612814E-03 -.42534660E-02
  .96750031E-09  .42209027E-09  .30963712E-08  .40516924E-04  .38549281E-02
 -.52714285E-03 -.87737477E-09  .53843743E-03  .38533672E-02 -.10363838E-09
  .38623427E-08 -.71743451E-08  .24131659E-03  .31427071E-02 -.10270931E-03
  .15812594E-09 -.20969267E-03  .31373775E-02  .44642715E-09  .28790083E-09
  .88009461E-09  .18408168E-03 -.17813513E-08 -.27431844E-08  .15957166E-04
 -.19242852E-02  .34087019E-03 -.22330623E-09  .41716037E-03  .19091971E-02
 -.71605887E-10  .95016675E-09 -.81490514E-09  .32861442E-02 -.18116747E-08
  .55541036E-09  .79551900E-03 -.41608643E-08 -.26069981E-09  .94036451E-02
  .21682867E-02 -.12127210E-02  .85710915E-08  .12126479E-02  .21683282E-02
 -.39141685E-08  .18971552E-02 -.12009168E-02  .43705940E-08  .12012029E-02
  .18969745E-02  .16937062E-07 -.67726532E-08 -.66549206E-08  .11440634E-01
  .49982895E-02 -.24804966E-02  .39527267E-09 -.24804686E-02 -.49983050E-02
 -.34622476E-08 -.50056020E-02  .25440974E-02 -.23331468E-08 -.25435047E-02
 -.50059046E-02 -.85708461E-08
  phi_t prime for node #          3
 -.50525028E-06 -.31564387E-05 -.80521842E-10  .31702786E-05 -.40940183E-06
  .57389171E-09 -.26678138E-11  .65900274E-12 -.58046889E-04  .10244708E-05
  .47674564E-05  .15531760E-10 -.47644389E-05  .10384376E-05  .44257276E-10
  .11200572E-10  .49389619E-11 -.61429724E-04  .68382965E-06  .54576833E-05
 -.20073106E-10 -.54985919E-05  .13880871E-06 -.11950858E-09 -.12906028E-11
  .35486701E-12 -.77274292E-04  .61171041E-11 -.56114520E-11 -.65377923E-04
 -.17172111E-05 -.54788611E-05  .24079039E-11 -.54062017E-05  .19338345E-05
  .41797610E-11  .67570000E-11  .20000043E-10  .51675836E-06 -.99163146E-11
 -.24536147E-10  .16113741E-05 -.24387637E-10 -.45291231E-10  .14474359E-04
  .40550997E-04  .55846277E-04 -.22605263E-10 -.55847708E-04  .40549096E-04
```

```
 -.12064872E-11  .40806300E-04  .51925447E-04 -.22326921E-10 -.51919351E-04
  .40814113E-04  .35521932E-10  .15828591E-09 -.16771401E-09  .21209458E-04
  .16987298E-03  .27619447E-03  .11975439E-09  .27619558E-03 -.16987148E-03
 -.57982074E-10 -.17376694E-03 -.27781790E-03 -.11765510E-09  .27783862E-03
 -.17373409E-03 -.70075300E-10
 phi_t for node #          4
 -.42404802E-02  .49480360E-03  .18585028E-08 -.36612933E-03 -.42535396E-02
  .21036956E-08  .39723035E-09 -.14786269E-09  .40516905E-04 -.38549306E-02
  .52714303E-03 -.77214743E-09 -.53843745E-03 -.38533660E-02  .20798890E-09
 -.73886299E-08 -.15978809E-07 -.24131650E-03  .31427093E-02 -.10270436E-03
  .13801450E-10 -.20968938E-03  .31373931E-02 -.39914612E-09  .41931685E-11
  .99616139E-10  .18408168E-03  .35438059E-09 -.17390277E-08 -.15957178E-04
  .19242857E-02 -.34087031E-03 -.23866856E-09 -.41716036E-03 -.19091972E-02
 -.19395891E-10  .94356214E-09 -.84924469E-09 -.32861442E-02  .18078300E-08
 -.56604075E-09  .79551900E-03 -.41738415E-08 -.28114281E-09 -.94036451E-02
  .21682868E-02 -.12127209E-02 -.85410786E-08  .12126480E-02  .21683284E-02
  .38256346E-08 -.18971552E-02  .12009169E-02  .43704936E-08 -.12012030E-02
 -.18969746E-02  .17005110E-07  .67789071E-08  .66775796E-08  .11440634E-01
  .49982897E-02 -.24804968E-02 -.39492666E-09 -.24804688E-02 -.49983053E-02
  .34827434E-08  .50056020E-02 -.25440973E-02 -.23324836E-08  .25435049E-02
  .50059050E-02 -.85841247E-08
 phi_t prime for node #          4
  .50524725E-06  .31564441E-05 -.82070494E-10 -.31703213E-05  .40940604E-06
  .62154334E-09  .34011412E-12 -.27858908E-12  .58046878E-04  .10244712E-05
  .47674599E-05  .13355611E-10 -.47644372E-05  .10384375E-05  .44054122E-10
 -.22077045E-10  .11247290E-10 -.61429722E-04 -.68382100E-06 -.54576879E-05
 -.24245181E-10  .54986198E-05 -.13881681E-06 -.15347238E-09  .50958361E-12
 -.41824742E-12  .77274292E-04 -.42833617E-11  .34928804E-12 -.65377921E-04
 -.17172117E-05 -.54788625E-05  .15891701E-11 -.54062019E-05  .19338345E-05
 -.90655410E-11 -.71395520E-11 -.19852937E-10  .51675837E-06 -.10061491E-10
 -.24464605E-10 -.16113739E-05  .23986931E-10  .45635598E-10  .14474359E-04
 -.40550995E-04 -.55846279E-04 -.22604313E-10  .55847713E-04 -.40549100E-04
 -.14851140E-11  .40806300E-04  .51925447E-04  .22357522E-10 -.51919354E-04
  .40814116E-04 -.35835384E-10  .15906312E-09 -.16795738E-09 -.21209458E-04
 -.16987299E-03 -.27619447E-03  .11979215E-09 -.27619560E-03  .16987149E-03
 -.57726900E-10 -.17376694E-03 -.27781789E-03  .11764036E-09  .27783864E-03
 -.17373411E-03  .70185849E-10
 mass matrix
  .10000000E+01 -.30291562E-01 -.76876291E-07  .73800796E-06  .32867117E-06
  .13158549E-06 -.92633251E-08 -.17952422E-07  .62673968E-08 -.19995321E-07
  .20953681E-06 -.61379992E-07  .12006683E-09 -.11753664E-09  .88805322E-10
  .18582751E-09  .93589593E-10  .34601899E-08  .12520782E-08  .51220876E-10
 -.26895388E-10 -.46932083E-10 -.51456416E-09 -.16699282E-09 -.30291562E-01
  .10000000E+01  .26989693E-07  .24701420E-07  .34123181E-05  .19569915E-07
  .18126030E-07 -.22083024E-07 -.30895835E-08 -.63797417E-09  .13846796E-06
 -.91584230E-06  .28463240E-09 -.92291186E-09  .13196997E-09 -.83498605E-10
 -.23061102E-09  .37066771E-09  .14015707E-07  .71524564E-09 -.97352491E-12
 -.79781628E-10 -.28504651E-10 -.24628018E-08 -.76876291E-07  .26989693E-07
  .10000000E+01 -.12820039E-07  .23873133E-06  .46502856E-07  .48615925E-08
 -.31587180E-08 -.94997621E-10 -.56075172E-08  .49113872E-08 -.51914907E-07
 -.57636964E-11  .45511296E-10  .45041193E-11 -.28608624E-10  .92163317E-11
 -.16290986E-10  .76859350E-09 -.31071312E-10 -.47158520E-11 -.13956592E-11
  .40931813E-11 -.13308932E-09  .73800796E-06  .24701420E-07 -.12820039E-07
  .10000000E+01  .29302137E-02  .10572523E-05 -.24430484E-06  .68476034E-07
  .92720426E-09 -.64534578E-07  .16242822E-07  .86600013E-08  .72440444E-09
  .16245107E-08 -.11209088E-09  .55930229E-10 -.44166054E-09 -.10256621E-08
 -.50144862E-09 -.15880740E-08  .25789654E-09 -.98514653E-10 -.37720327E-09
  .27460623E-09  .32867117E-06  .34123181E-05  .23873133E-06  .29302137E-02
  .10000000E+01  .71189247E-06 -.53815780E-06 -.15566832E-05  .83251907E-07
 -.45009419E-07 -.44807150E-07  .17705875E-07 -.16602525E-08 -.43070508E-08
 -.20692528E-09  .20019442E-08  .57241159E-08 -.72556163E-09  .93151063E-09
  .18206492E-08 -.13561118E-09 -.12897281E-08 -.25829052E-10  .16156569E-09
  .13158549E-06  .19569915E-07  .46502856E-07  .10572523E-05  .71189247E-06
  .10000000E+01 -.83160269E-07  .24349543E-07  .11233865E-07  .10028917E-06
 -.12313102E-06  .70134651E-07 -.13207290E-08  .28173844E-08 -.11660397E-08
  .22882173E-09 -.30171128E-09 -.14728997E-08 -.13109908E-08  .32317686E-09
  .12105915E-10 -.55168990E-10  .27914248E-09  .14656790E-09 -.92633250E-08
  .18126030E-07  .48615925E-08 -.24430484E-06 -.53815780E-06 -.83160269E-07
  .10000000E+01 -.99242756E-01  .22394316E-07 -.39958298E-07  .32234509E-06
 -.50160922E-06  .23636843E-09 -.21910738E-09  .14348669E-09  .15847338E-09
  .74774558E-10  .32733302E-08  .57239272E-08  .10031900E-09 -.36640911E-10
```

-.81560611E-10	-.45187655E-09	-.93057423E-09	-.17952422E-07	-.22083024E-07
-.31587180E-08	.68476034E-07	-.15566832E-05	.24349543E-07	-.99242756E-01
.10000000E+01	-.20074054E-07	.16458235E-07	.15485050E-06	-.15630944E-05
.29386609E-09	-.10163269E-08	.11846928E-09	-.20501990E-09	-.41770205E-09
-.56246450E-09	.16797163E-07	.78252621E-09	.33675344E-11	-.57812240E-10
.11108613E-09	-.29422473E-08	.62673968E-08	-.30895835E-08	-.94997760E-10
.92720426E-09	.83251907E-07	.11233865E-07	.22394316E-07	-.20074054E-07
.10000000E+01	.12712850E-07	-.23627686E-07	.15204590E-06	.96068819E-11
-.66710239E-10	-.23527708E-12	.57865057E-10	-.34048646E-10	-.56274547E-10
-.13467924E-08	.57321148E-10	.72512622E-11	.43261077E-11	.42475879E-11
.23009307E-09	-.19995321E-07	-.63797417E-09	-.56075174E-08	-.64534578E-07
-.45009419E-07	.10028917E-06	-.39958298E-07	.16458235E-07	.12712850E-07
.10000000E+01	.34013758E-06	-.19456390E-06	.12276100E-08	-.23143374E-08
.90995226E-09	-.20703316E-09	.26711414E-09	.17484259E-08	.14384415E-08
-.22089987E-09	-.12869248E-10	.38339013E-10	-.31448481E-09	-.18544250E-09
.20953681E-06	.13846796E-06	.49113872E-08	.16242822E-07	-.44807150E-07
-.12313102E-06	.32234509E-06	.15485050E-06	-.23627686E-07	.34013758E-06
.10000000E+01	-.39786267E-01	.17049808E-08	.38885439E-08	-.46588188E-09
.12616452E-08	.13318808E-08	-.42894021E-08	.74108288E-09	-.45855306E-08
.76304756E-09	-.90324773E-09	-.10747486E-08	.61285555E-09	-.61379992E-07
-.91584230E-06	-.51914907E-07	.86600013E-08	.17705875E-07	.70134651E-07
-.50160922E-06	-.15630944E-05	.15204590E-06	-.19456390E-06	-.39786267E-01
.10000000E+01	.62505978E-08	.15167020E-07	.64225500E-09	-.64493380E-08
-.19359751E-07	.14627884E-08	-.39742767E-08	-.61200326E-08	.51696455E-09
.41021165E-08	.38755886E-10	-.28087086E-09	.12006683E-09	.28463240E-09
-.57637523E-11	.72440444E-09	-.16602525E-08	-.13207290E-08	.23636843E-09
.29386609E-09	.96069199E-11	.12276100E-08	.17049808E-08	.62505978E-08
.10000000E+01	.73552646E-10	.38814802E-10	.36872491E-10	.72462767E-10
-.30908303E-09	.78347194E-09	-.80736378E-10	.38873326E-11	-.52248843E-11
.43195040E-10	-.10247581E-09	-.11753664E-09	-.92291186E-09	.45511310E-10
.16245107E-08	-.43070508E-08	.28173844E-08	-.21910738E-09	-.10163269E-08
-.66710219E-10	-.23143374E-08	.38885439E-08	.15167020E-07	.73552316E-10
.10000000E+01	-.15617476E-09	-.61749360E-11	-.26777146E-09	-.10599770E-08
.29161646E-08	-.20094998E-09	.18211917E-10	.26472063E-10	.16702574E-09
-.34247066E-09	.88805322E-10	.13196997E-09	.45041462E-11	-.11209088E-09
-.20692528E-09	-.11660397E-08	.14348669E-09	.11846928E-09	-.23525973E-12
.90995225E-09	-.46588188E-09	.64225500E-09	.38814889E-10	-.15617482E-09
.10000000E+01	.12187317E-09	.15001747E-09	.24640744E-09	.42025294E-09
-.18289440E-09	.56313574E-11	-.72942198E-11	-.17559408E-10	-.32344202E-10
.18582743E-09	-.83498576E-10	-.28608624E-10	.55930264E-10	.20019442E-08
.22882173E-09	.15847327E-09	-.20501985E-09	.57865057E-10	-.20703316E-09
.12616453E-08	-.64493380E-08	.36872491E-10	-.61749360E-11	.12187317E-09
.10000000E+01	-.32661816E-04	-.43944057E-08	-.24952357E-07	.81538381E-10
.34212335E-10	.38356819E-10	.24612814E-10	.46331501E-09	.93589566E-10
-.23061114E-09	.92163317E-11	-.44166048E-09	.57241158E-08	-.30171128E-09
.74774490E-10	-.41770205E-09	-.34048646E-10	.26711414E-09	.13318808E-08
-.19359751E-07	.72462767E-10	-.26777146E-09	.15001747E-09	-.32661816E-04
.10000000E+01	.42300905E-08	-.73197671E-07	-.10441846E-08	-.14602376E-11
.73313057E-10	-.10191802E-09	.14986050E-08	.34601900E-08	.37066776E-09
-.16290986E-10	-.10256622E-08	-.72556165E-09	-.14728997E-08	.32733303E-08
-.56246452E-09	-.56274547E-10	.17484259E-08	-.42894022E-08	.14627883E-08
-.30908303E-09	-.10599770E-08	.24640744E-09	-.43944057E-08	.42300905E-08
.10000000E+01	.15221368E-03	-.86338705E-08	.45921228E-09	-.20521056E-09
-.89116174E-09	.26024348E-09	.12520782E-08	.14015707E-07	.76859350E-09
-.50144861E-09	.93151061E-09	-.13109908E-08	.57239273E-08	.16797163E-07
-.13467924E-08	.14384415E-08	.74108288E-09	-.39742767E-08	.78347194E-09
.29161646E-08	.42025294E-09	-.24952357E-07	-.73197671E-07	.15221368E-03
.10000000E+01	.96863908E-08	-.22080642E-09	-.21316144E-08	-.16738301E-09
.50310155E-09	.51220876E-10	.71524564E-09	-.31071253E-10	-.15880740E-08
.18206492E-08	.32317686E-09	.10031900E-09	.78252621E-09	.57321209E-10
-.22089988E-09	-.45855306E-08	-.61200326E-08	-.80736291E-10	-.20094994E-09
-.18289443E-09	.81538381E-10	-.10441846E-08	-.86338705E-08	.96863908E-08
.10000000E+01	-.83286638E-10	-.96200651E-10	-.75748973E-09	.64933845E-09
-.26895791E-10	-.97338757E-12	-.47158520E-11	.25789669E-09	-.13561120E-09
.12105915E-10	-.36641097E-10	.33675814E-11	.72512622E-11	-.12869248E-10
.76304768E-09	.51696454E-09	.38873326E-11	.18211917E-10	.56313574E-11
.34212015E-10	-.14603011E-11	.45921242E-09	-.22080646E-09	-.83286638E-10
.10000000E+01	.58959486E-05	.14665321E-07	-.85539216E-08	-.46932053E-10
-.79781317E-10	-.13956592E-11	-.98514661E-10	-.12897281E-08	-.55168990E-10
-.81560497E-10	-.57812195E-10	.43261077E-11	.38339013E-10	-.90324783E-09
.41021164E-08	-.52248843E-11	.26472063E-10	-.72942198E-11	.38356856E-10

.73313071E-10	-.20521064E-09	-.21316143E-08	-.96200651E-10	.58959486E-05
.10000000E+01	-.59777300E-08	-.75550117E-07	-.51456404E-09	-.28504694E-10
.40931813E-11	-.37720340E-09	-.25829159E-10	.27914248E-09	-.45187665E-09
.11108611E-09	.42475879E-11	-.31448481E-09	-.10747487E-08	.38755748E-10
.43195040E-10	.16702574E-09	-.17559408E-10	.24612970E-10	-.10191791E-09
-.89116176E-09	-.16738308E-09	-.75748973E-09	.14665321E-07	-.59777301E-08
.10000000E+01	-.11866292E-03	-.16699269E-09	-.24628016E-08	-.13308932E-09
.27460630E-09	.16156571E-09	.14656790E-09	-.93057434E-09	-.29422474E-08
.23009307E-09	-.18544250E-09	.61285545E-09	-.28087069E-09	-.10247581E-09
-.34247066E-09	-.32344202E-10	.46331502E-09	.14986050E-08	.26024357E-09
.50310165E-09	.64933845E-09	-.85539216E-08	-.75550117E-07	-.11866292E-03
.10000000E+01				

damping matrix

.39515996E-02	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.39516161E-02	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.57051589E-02	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.10312256E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.10312269E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.11723114E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.18482064E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.18482067E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.21730454E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.26395027E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.33015249E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.33015287E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00

.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.85110374E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.96499772E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.12323587E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.14322839E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.14322847E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.14874285E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.14874293E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.16365219E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.23335965E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.23335978E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.23420770E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.23420782E+00				

stiffness matrix

.97594620E-02	-.29562935E-03	-.75027124E-09	.72025612E-08	.32076552E-08
.12842036E-08	-.90451014E-10	-.17520828E-09	.61166345E-10	-.19514395E-09
.20449663E-08	-.59903455E-09	.11734955E-11	-.11566431E-11	.82897331E-12
.18224390E-11	.91230355E-12	.33761495E-10	.12195177E-10	.39046523E-12
-.23182122E-12	-.45045983E-12	-.50303460E-11	-.16273291E-11	-.29563182E-03
.97595435E-02	.26340700E-09	.24106267E-09	.33302668E-07	.19099210E-09
.17684183E-09	-.21551112E-09	-.30152319E-10	-.62306491E-11	.13513914E-08
-.89381996E-08	.28259460E-11	-.90398944E-11	.13342475E-11	-.81528791E-12
-.22587225E-11	.35773535E-11	.13680596E-09	.72885717E-11	.13210152E-12
-.79094623E-12	-.24557427E-12	-.23989233E-10	-.15639020E-08	.54905123E-09
.20343024E-01	-.26079975E-09	.48565154E-08	.94600863E-09	.98901407E-10
-.64254611E-10	-.19314411E-11	-.11407272E-09	.99913434E-10	-.10561077E-08

-.12958944E-12	.94279651E-12	.10015730E-12	-.57997122E-12	.18743726E-12
-.33130988E-12	.15637630E-10	-.59105368E-12	-.93439414E-13	-.27921324E-13
.81773561E-13	-.27093940E-11	.49050780E-07	.16417779E-08	-.85207293E-09
.66464133E-01	.19475411E-03	.70269359E-07	-.16237297E-07	.45511788E-08
.61626102E-10	-.42892336E-08	.10795968E-08	.57553439E-09	.48250404E-10
.10784259E-09	-.75078960E-11	.38099994E-11	-.29288332E-10	-.68250243E-10
-.33409452E-10	-.10524932E-09	.17471826E-10	-.66418785E-11	-.25134243E-10
.18277811E-10	.21845110E-07	.22679724E-06	.15867112E-07	.19475462E-03
.66464305E-01	.47315439E-07	-.35768462E-07	-.10346396E-06	.55332801E-08
-.29915172E-08	-.29780635E-08	.11768222E-08	-.11051827E-09	-.28583534E-09
-.13254065E-10	.13294086E-09	.38057802E-09	-.48296946E-10	.62028220E-10
.12099541E-09	-.92194702E-11	-.85621868E-10	-.16899667E-11	.10770092E-10
.11302504E-07	.16809534E-08	.39943453E-08	.90812287E-07	.61147734E-07
.85894623E-01	-.71430461E-08	.20915017E-08	.96492788E-09	.86143002E-08
-.10576290E-07	.60241884E-08	-.11344353E-09	.24197689E-09	-.10012414E-09
.19655470E-10	-.25911887E-10	-.12651469E-09	-.11260067E-09	.27711122E-10
.10422433E-11	-.47322329E-11	.23975455E-10	.12585346E-10	-.19775410E-08
.38697774E-08	.10379095E-08	-.52157042E-07	-.11489221E-06	-.17754025E-07
.21349168E+00	-.21187502E-01	.47810000E-08	-.85307615E-08	.68817988E-07
-.10708940E-06	.50448730E-10	-.46755022E-10	.30712267E-10	.33803654E-10
.15965556E-10	.69886272E-09	.12220632E-08	.21628280E-10	-.78725297E-11
-.17381897E-10	-.96488084E-10	-.19868499E-09	-.38323239E-08	-.47144921E-08
-.67436058E-09	.14619108E-07	-.33233900E-06	.51984276E-08	-.21187509E-01
.21349175E+00	-.42856447E-08	.35137127E-08	.33059276E-07	-.33370775E-06
.62597345E-10	-.21700140E-09	.25569023E-10	-.43772625E-10	-.89149742E-10
-.12003948E-09	.35860843E-08	.16675823E-09	.65427100E-12	-.12334270E-10
.23731088E-10	-.62821713E-09	.18497242E-08	-.91183816E-09	-.28036982E-10
.27364911E-09	.24570374E-07	.33154821E-08	.66093311E-08	-.59245192E-08
.29513290E+00	.37519809E-08	-.69733084E-08	.44873745E-07	.28192923E-11
-.19683526E-10	-.11199895E-12	.17068733E-10	-.10047449E-10	-.16608589E-10
-.39748348E-09	.16947454E-10	.21308173E-11	.12755192E-11	.12553181E-11
.67910129E-10	-.87066875E-08	-.27779292E-09	-.24417141E-08	-.28100677E-07
-.19598723E-07	.43669505E-07	-.17399277E-07	.71665128E-08	.55356311E-08
.43543590E+00	.14810812E-06	-.84720111E-07	.53455607E-09	-.10077465E-08
.39621050E-09	-.90142789E-10	.11631096E-09	.76132617E-09	.62634874E-09
-.96162869E-10	-.55908969E-11	.16693329E-10	-.13693987E-09	-.80752431E-10
.14274801E-06	.94331868E-07	.33459029E-08	.11065514E-07	-.30525020E-07
-.83883518E-07	.21959873E-06	.10549258E-06	-.16096458E-07	.23172014E-06
.68125418E+00	-.27104561E-01	.11614789E-08	.26490362E-08	-.31716511E-09
.85943274E-09	.90728701E-09	-.29221317E-08	.50490366E-09	-.31241205E-08
.51957049E-09	-.61526398E-09	-.73211418E-09	.41751702E-09	-.41815403E-07
-.62392289E-06	-.35367329E-07	.58996564E-08	.12062234E-07	.47779635E-07
-.34172432E-06	-.10648671E-05	.10358214E-06	-.13254778E-06	-.27104623E-01
.68125575E+00	.42582183E-08	.10332833E-07	.43797025E-09	-.43936896E-08
-.13188862E-07	.99646725E-09	-.27074259E-08	-.41693831E-08	.35204549E-09
.27946747E-08	.26429309E-10	-.19132813E-09	.54370530E-09	.12885390E-08
-.26094123E-10	.32796145E-08	-.75165501E-08	-.59794170E-08	.10704220E-08
.13302950E-08	.43492383E-10	.55578312E-08	.77190818E-08	.28298716E-07
.45273599E+01	.33289908E-09	.17573194E-09	.16686711E-09	.32812234E-09
-.13993111E-08	.35471410E-08	-.36583693E-09	.17545295E-10	-.23583057E-10
.19549301E-09	-.46399077E-09	-.68383088E-09	-.53715190E-08	.26488114E-09
.94548621E-08	-.25067621E-07	.16397539E-07	-.12751511E-08	-.59152219E-08
-.38826234E-09	-.13469743E-07	.22631843E-07	.88273977E-07	.42812130E-09
.58201288E+01	-.90943330E-09	-.36104962E-10	-.15585213E-08	-.61692245E-08
.16972432E-07	-.11689674E-08	.10556426E-09	.15428061E-09	.97207921E-09
-.19932091E-08	.84272535E-09	.12524416E-08	.42753780E-10	-.10640459E-08
-.19639654E-08	-.11067963E-07	.13620121E-08	.11243940E-08	-.22333246E-11
.86371992E-08	-.44220668E-08	.60963545E-08	.36836949E-09	-.14823860E-08
.94919248E+01	.11569532E-08	.14240477E-08	.23390508E-08	.39891144E-08
-.17362158E-08	.53773057E-10	-.69087488E-10	-.16684484E-09	-.30710330E-09
.23825826E-08	-.10705752E-08	-.36680513E-09	.71712112E-09	.25667901E-07
.29338338E-08	.20318696E-08	-.26286568E-08	.74191582E-09	-.26544722E-08
.16176156E-07	-.82690075E-07	.47275881E-09	-.79170095E-10	.15625947E-08
.12821483E+02	-.41877293E-03	-.56342791E-07	-.31992622E-06	.10454387E-08
.43863811E-09	.49179440E-09	.31556405E-09	.59403734E-08	.11999282E-08
-.29567965E-08	.11817227E-09	-.56627605E-08	.73391744E-07	-.38683881E-08
.95862784E-09	-.53555396E-08	-.43655302E-09	.34248007E-08	.17076716E-07
-.24822099E-06	.92912736E-09	-.34332976E-08	.19234540E-08	-.41877339E-03
.12821497E+02	.54236081E-07	-.93850374E-06	-.13387797E-07	-.18793480E-10
.94000040E-09	-.13067391E-08	.19214341E-07	.47846913E-07	.51256077E-08
-.22527256E-09	-.14182629E-07	-.10032981E-07	-.20366924E-07	.45262964E-07

```
 -.77773881E-08 -.77815894E-09  .24176875E-07 -.59312892E-07  .20227043E-07
 -.42740708E-08 -.14657279E-07  .34081278E-08 -.60764954E-07  .58492524E-07
  .13827771E+02  .21047759E-02 -.11938795E-06  .63495967E-08 -.28372832E-08
 -.12322523E-07  .35987854E-08  .17313572E-07  .19380609E-06  .10627946E-07
 -.69339030E-08  .12880785E-07 -.18128101E-07  .79148965E-07  .23226738E-06
 -.18623154E-07  .19890436E-07  .10247543E-07 -.54955412E-07  .10833735E-07
  .40324285E-07  .58103208E-08 -.34503589E-06 -.10121617E-05  .21047783E-02
  .13827787E+02  .13394160E-06 -.30532164E-08 -.29475699E-07 -.23147128E-08
  .69566688E-08  .85737493E-09  .11972471E-07 -.52009481E-09 -.26582230E-07
  .30475180E-07  .54095867E-08  .16790539E-08  .13098546E-07  .95948868E-09
 -.36975908E-08 -.76756243E-07 -.10244206E-06 -.13514731E-08 -.33636087E-08
 -.30612494E-08  .13646379E-08 -.17478437E-07 -.14452064E-06  .16213823E-06
  .16738775E+02 -.13945359E-08 -.16103805E-08 -.12679180E-07  .10869214E-07
 -.91550650E-09 -.33334156E-10 -.16050637E-09  .87776220E-08 -.46153852E-08
  .41203041E-09 -.12472661E-08  .11467520E-09  .24680008E-09 -.43801066E-09
  .25970692E-07  .17595245E-07  .13230540E-09  .61985082E-09  .19168201E-09
  .11644931E-08 -.49596044E-10  .15629549E-07 -.75152029E-08 -.28347009E-08
  .34035455E+02  .20067129E-03  .49914084E-06 -.29113677E-06 -.15969909E-08
 -.27153113E-08 -.47502223E-10 -.33529005E-08 -.43896635E-07 -.18777036E-08
 -.27762546E-08 -.19675833E-08  .14724131E-09  .13048872E-08 -.30742521E-07
  .13961746E-06 -.17783387E-09  .90098960E-09 -.24823965E-09  .13055799E-08
  .24952241E-08 -.69844069E-08 -.72550516E-07 -.32742397E-08  .20067151E-03
  .34035491E+02 -.20345508E-06 -.25713854E-05 -.17642842E-07 -.97773383E-09
  .14035968E-09 -.12931820E-07 -.88486304E-09  .95699556E-08 -.15492845E-07
  .38072643E-08  .14565520E-09 -.10781761E-07 -.36845727E-07  .13291458E-08
  .14814849E-08  .57271389E-08 -.60505547E-09  .84480496E-09 -.34929367E-08
 -.30551212E-07 -.57376276E-08 -.25966143E-07  .50277715E-06 -.20493817E-06
  .34283278E+02 -.40681539E-02 -.57248771E-08 -.84432571E-07 -.45627666E-08
  .94143010E-08  .55387795E-08  .50248116E-08 -.31901744E-07 -.10086897E-06
  .78883295E-08 -.63574471E-08  .21010657E-07 -.96293667E-08 -.35136868E-08
 -.11741684E-07 -.11054520E-08  .15883512E-07  .51376341E-07  .89214834E-08
  .17247322E-07  .22259068E-07 -.29325792E-06 -.25901072E-05 -.40681582E-02
  .34283314E+02
         *** zeroth order terms ***


  alpha
 -.42285318E-07  .22032523E-08  .19103434E-08 -.46164709E-09 -.25254923E-07
  .15319234E-08 -.92689514E-10 -.41002187E-09 -.56423913E-10  .53935514E-09
  .39637933E-10 -.80781973E-09  .34687579E-10 -.27100970E-09  .57689693E-10
 -.98124081E-10  .42222814E-08  .46766094E-10 -.23190343E-08 -.21012612E-09
  .84068331E-10  .67994729E-09 -.13698436E-08  .62753410E-10  .11096251E-10
  .39006386E-10  .73868759E-11  .27987870E-11 -.62247277E-09 -.59775470E-11
  .17590884E-09  .76219460E-11 -.26366890E-09  .11876573E-10  .28290161E-10
 -.27201298E-10  .89869863E-12 -.15751250E-11 -.33157375E-12  .70866876E-12
 -.24551181E-11 -.42785452E-10  .34373229E-12  .11944186E-12 -.30843212E-12
  .15203202E-10  .15923719E-12 -.27557073E-12 -.68722572E-12  .78199706E-11
 -.53600279E-12  .35222275E-11 -.10833770E-12 -.38667210E-11  .24012255E-12
 -.22349588E-13  .72325799E-13 -.72369183E-12  .14903493E-11  .24910814E-10
  .17123480E-11  .30860344E-13  .45896282E-13  .35510380E-13 -.12439625E-11
  .66833265E-13 -.45804903E-12 -.82105459E-14  .84237205E-12  .62945655E-13
 -.81003566E-13  .43653901E-13
  h matrix
 -.41919760E+00  .56538237E+00 -.43485534E-01 -.48726399E+01 -.14092839E+00
  .31621688E+00 -.15658688E+00 -.17361672E-01 -.21636943E-02 -.21186125E-01
  .26295445E+00  .10634541E-02  .39837270E+00  .24038060E-01  .34138213E-02
  .72810429E-01 -.66125938E-01 -.14508666E-01 -.87470672E-01  .13982584E-01
  .20325687E-02 -.26138318E+00 -.13271355E-01  .17000778E-01  .16625637E-01
 -.30466702E-03  .92471384E-04 -.13678233E-01  .14351589E-01  .35179758E-02
  .18275688E-02  .81441214E-01  .37327408E-03 -.11565896E+00 -.94944608E-03
 -.86128442E-03 -.44776941E-03 -.16313018E-03 -.15718717E-04 -.10522228E-02
  .90631992E-05  .49761828E-04 -.64926039E-04  .27152761E-04 -.19410130E-04
  .46028011E-03  .13453022E-03  .19224888E-06  .13666807E-02  .14309527E-03
 -.11088438E-03 -.18934576E-03  .15159582E-02  .53961923E-05  .20500426E-02
  .20016096E-03  .90999899E-05  .44426853E-03  .45524403E-04  .33906200E-05
 -.32663380E-04 -.43305067E-04 -.94350657E-07 -.31076189E-03  .13804808E-04
  .12272265E-04 -.36541686E-04 -.23880534E-03 -.33501440E-06 -.17757456E-03
 -.13655382E-03 -.30751912E-05
  s1
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
```

```
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00
   *** first order terms ***

 i_1  m_i^b
 .89381792E-01  .00000000E+00  .00000000E+00  .00000000E+00  .89381792E-01
 .00000000E+00 -.58177179E+00 -.43307251E+00  .00000000E+00 -.10178988E+01
 .00000000E+00  .00000000E+00  .00000000E+00 -.10178988E+01  .00000000E+00
 .15376649E+00 -.50245233E+01  .00000000E+00  .71852291E-02  .00000000E+00
 .00000000E+00  .00000000E+00  .71852291E-02  .00000000E+00  .28424090E-01
-.17291849E+00  .00000000E+00 -.10551282E-01  .00000000E+00  .00000000E+00
 .00000000E+00 -.10551282E-01  .00000000E+00 -.40492477E+05 -.23515802E+04
 .00000000E+00 -.31408004E-01  .00000000E+00  .00000000E+00  .00000000E+00
-.31408004E-01  .00000000E+00  .22328507E+04 -.40498476E+05  .00000000E+00
 .33870978E+05  .00000000E+00  .00000000E+00  .00000000E+00  .33870978E+05
 .00000000E+00  .24388227E-01  .23658852E-01  .00000000E+00  .31851587E-01
 .00000000E+00  .00000000E+00  .00000000E+00  .31851587E-01  .00000000E+00
-.16187775E-01 -.96444085E-01  .00000000E+00 -.53418857E-01  .00000000E+00
 .00000000E+00  .00000000E+00 -.53418857E-01  .00000000E+00  .12105322E-01
-.28935991E+00  .00000000E+00 -.11132880E-03  .00000000E+00  .00000000E+00
 .00000000E+00 -.11132880E-03  .00000000E+00 -.11476862E-02  .30969398E-01
 .00000000E+00 -.22321987E+05  .00000000E+00  .00000000E+00  .00000000E+00
-.22321987E+05  .00000000E+00 -.31998031E-01 -.29477051E-01  .00000000E+00
 .11286377E-02  .00000000E+00  .00000000E+00  .00000000E+00  .11286377E-02
 .00000000E+00 -.59876589E+05 -.98431220E+04  .00000000E+00 -.35882781E-02
 .00000000E+00  .00000000E+00  .00000000E+00 -.35882781E-02  .00000000E+00
-.74530641E+04  .60220631E+05  .00000000E+00  .34407691E+06  .00000000E+00
 .00000000E+00  .00000000E+00  .34407691E+06  .00000000E+00 -.20702927E-04
 .84613530E-04  .00000000E+00 -.20271109E-05  .00000000E+00  .00000000E+00
 .00000000E+00 -.20271109E-05  .00000000E+00  .60214464E-02  .31309394E-02
 .00000000E+00  .21803208E+06  .00000000E+00  .00000000E+00  .00000000E+00
 .21803208E+06  .00000000E+00  .35046731E-06  .20448791E-05  .00000000E+00
```

.13462938E+00	.00000000E+00	.00000000E+00	.00000000E+00	.13462938E+00
.00000000E+00	.25977374E-05	.10399210E-03	.00000000E+00	-.81973301E-01
.00000000E+00	.00000000E+00	.00000000E+00	-.81973301E-01	.00000000E+00
-.15155120E-04	.18537988E-03	.00000000E+00	-.55950132E-05	.00000000E+00
.00000000E+00	.00000000E+00	-.55950132E-05	.00000000E+00	-.50422495E+04
-.40884484E+02	.00000000E+00	-.70074319E-03	.00000000E+00	.00000000E+00
.00000000E+00	-.70074319E-03	.00000000E+00	.40113806E+02	-.50422499E+04
.00000000E+00	-.10789343E-03	.00000000E+00	.00000000E+00	.00000000E+00
-.10789343E-03	.00000000E+00	-.15519734E-03	.54725953E-02	.00000000E+00
-.15473569E-01	.00000000E+00	.00000000E+00	.00000000E+00	-.15473569E-01
.00000000E+00	-.44691498E-04	.61545868E-04	.00000000E+00	-.16490171E-01
.00000000E+00	.00000000E+00	.00000000E+00	-.16490171E-01	.00000000E+00
.70316673E-04	.10593837E-03	.00000000E+00	-.22504118E-05	.00000000E+00
.00000000E+00	.00000000E+00	-.22504118E-05	.00000000E+00	-.30912152E+04
.15565069E+04	.00000000E+00	.66447651E-04	.00000000E+00	.00000000E+00
.00000000E+00	.66447651E-04	.00000000E+00	-.15561377E+04	-.30913985E+04
.00000000E+00				

gamma_2 y_ki^b

-.62607851E-07	-.50794938E-06	.17478712E-01	.51856264E-06	-.78861303E-08
-.10052474E+01	-.73381075E-03	-.13366523E-01	.45386799E-06	.36717330E-07
.34244087E-06	.21280028E-06	-.34124540E-06	.38838113E-07	-.21262985E-06
-.33159527E-07	.43796371E-07	-.24642116E-05	.13404742E-06	-.82364180E-06
.18701826E-02	.80726494E-06	.22112481E-06	.17620561E-01	-.53324649E-02
-.28274991E-01	-.60964083E-07	.18974310E-07	-.16027134E-07	.26374269E-06
.21157972E-08	-.24413690E-06	-.10930903E-06	-.24235997E-06	.10887613E-07
-.13773702E-06	-.74355275E-06	.86344820E-06	-.86348556E-08	-.10594211E+00
-.72922176E-01	.12741219E-07	-.80583169E-06	.12968028E-05	-.14501437E-06
-.91143541E-07	.15942143E-06	-.12557840E+00	-.16085783E-06	-.84422487E-07
.47379413E+00	-.16763984E-06	-.73009900E-06	.48745525E-06	-.27553639E-06
-.28304144E-05	-.20161874E-06	-.21301848E+00	-.18980035E+01	-.16449225E-07
-.15146456E-06	-.22667613E-06	-.27864015E+00	-.22686122E-06	.15001301E-06
-.75692354E+00	.85227134E-07	.54382657E-06	-.11012196E-05	.35436475E-07
.14708492E-05	.62332048E-06	-.51856264E-06	.78861303E-08	.10052474E+01
.38444042E-06	-.36081121E-07	.17478850E-01	.13382617E-01	-.32858247E-03
-.72393559E-07	-.19119526E-07	-.39108756E-06	.34672207E-05	.38988118E-06
-.19214899E-07	-.15281638E-07	-.38279177E-06	-.12413706E-07	-.11021283E-06
.99446352E-07	-.60651059E-06	-.17943828E-01	.58761898E-06	.15995717E-06
.31010888E-02	.28423613E-01	-.44735140E-02	.26039509E-08	.16609008E-06
.45472414E-07	.37293498E-07	-.10498110E-06	.45860445E-06	-.93834662E-06
.45908021E-06	.88219631E-07	.18403367E-06	-.78571358E-05	-.80752560E-06
-.22489195E-06	.76105503E-01	-.10368437E+00	.15769748E-08	-.10568617E-04
.57565891E-06	.76217949E-06	-.74044170E-07	.11391547E-06	-.46976639E+00
-.12058674E-06	-.75683469E-07	-.13985513E+00	.10506104E-05	.54053200E-06
.30253741E-05	.21515236E-05	.12619873E-06	.20116967E-05	.19035792E+01
-.15542683E+00	-.27743136E-08	-.12645160E-06	-.20146267E-06	-.74812742E+00
-.20000508E-06	.12631014E-06	.30143385E+00	-.10593951E-05	-.15030137E-05
-.77536846E-05	.10054546E-06	-.52218327E-06	-.39275247E-05	.73381075E-03
.13366523E-01	-.45386799E-06	-.13382617E-01	.32858247E-03	.72393559E-07
.54588498E-07	-.11666072E-07	.14310395E-13	-.71385118E-09	.88880863E-08
.18767167E-06	.19211684E-08	.68511270E-09	.23711830E-07	.25343822E-07
-.10409501E-07	.56561332E-12	-.21846001E-01	.12358662E+00	.57679267E-07
-.12080850E+00	-.34003255E-01	-.19362683E-07	-.45282224E-07	.61839009E-08
.75797873E-14	.13743203E-06	.22855908E-08	-.88236331E-13	-.28600792E-09
.22856711E-07	-.87464909E-07	-.79568074E-08	.51110757E-09	.14175266E-07
-.23010227E-06	-.98727685E-07	.43416653E-13	-.24898360E-06	.91483883E-07
-.77664092E-13	-.45284969E-06	.42741722E-07	-.21249170E-12	-.13278546E-01
-.52285061E-01	.14719014E-06	.52285564E-01	-.13276810E-01	-.63399074E-08
-.26217801E-08	-.39483112E-08	.92799969E-07	.35017562E-08	-.20853839E-08
.83171247E-07	-.65246642E-06	.17160470E-06	-.41382889E-12	-.23320671E-01
-.71358750E-01	.15696020E-06	-.71358882E-01	.23320214E-01	-.38814806E-07
.47261019E-08	.11104159E-07	-.25209767E-06	-.82271192E-08	.34017979E-08
-.17927404E-06	-.36717330E-07	-.34244087E-06	-.21280028E-06	.19119526E-07
.39108756E-06	-.34672207E-05	.71385118E-09	-.88880863E-08	-.18767167E-06
.77264000E-09	.56089073E-08	.25542566E-01	-.54712968E-08	.45510576E-09
-.83092402E+00	-.28447933E-03	.22671016E-02	-.12113218E-05	-.56448434E-07
.24611815E-06	.73965692E-06	-.24294989E-06	-.44164116E-07	.23229657E-05
-.35178955E-09	-.14722675E-07	-.16092113E-06	.65717217E-02	.49474668E-01
.21395490E-06	-.14410719E-08	-.40903978E-08	.60441216E-01	-.11126326E-08
.49737407E-08	-.53923648E+00	-.94714179E-01	-.64899273E+00	-.34678836E-08
-.10559694E-07	-.39960159E-06	.37782460E-06	.13940018E+00	.12146079E+01
-.12958433E-08	.19372121E-06	.13219075E-05	.14943658E-08	.80698553E-07

-.19053734E-06	.77887080E-07	.39680923E-08	.64423900E-08	.19692464E-01
-.67860925E-08	.11108030E-08	-.36522737E-04	-.71710619E-08	-.46661594E-06
.20025118E-06	.65869035E-07	.31119132E-06	-.19170180E-07	-.48891040E-08
-.41439984E-06	-.18152134E-07	-.76837879E-08	-.16366625E-07	-.11419001E+00
.16399263E-07	-.73058140E-08	.94493068E-01	.34124540E-06	-.38838113E-07
.21262985E-06	-.38988118E-06	.19214899E-07	.15281638E-07	-.19211684E-08
-.68511270E-09	-.23711830E-07	.54712968E-08	-.45510576E-09	.83092402E+00
-.17031265E-07	.24014354E-08	.25542495E-01	-.22678700E-02	-.27782968E-03
.11184452E-05	.62194659E-07	-.47712538E-06	-.76244129E-07	.43215597E-06
.10569704E-06	.33350487E-07	-.71735340E-08	-.38147924E-09	.10918412E-07
-.49455263E-01	.67166526E-02	-.25146107E-06	-.93566548E-09	-.57381558E-08
-.53707875E+00	-.90587906E-08	.40903232E-08	-.40597617E-01	.64871410E+00
-.96615212E-01	-.60262836E-09	-.18891624E-06	-.98396479E-08	.89202189E-07
-.12141936E+01	.14295856E+00	.23050185E-09	-.14209128E-05	.23416354E-06
.35761913E-07	.15420580E-06	-.19440207E-07	.14128991E-08	.11873660E-07
.19292084E-07	.96879863E-04	-.16434235E-07	.11524456E-07	.19691541E-01
-.22074571E-06	-.15404011E-07	-.27221783E-06	-.28954207E-06	.78314182E-07
.29898828E-08	.42591726E-06	-.27558297E-07	-.32855064E-08	-.22910605E-07
-.48721700E-07	-.94812449E-01	.48349038E-07	-.22872252E-07	-.11390138E+00
.33159527E-07	-.43796371E-07	.24642116E-05	.38279177E-06	.12413706E-07
.11021283E-06	-.25343822E-07	.10409501E-07	-.56561332E-12	.28447933E-03
-.22671016E-02	.12113218E-05	.22678700E-02	.27782968E-03	-.11184452E-05
-.38364585E-09	-.37498631E-08	.35516869E-12	-.22295994E-07	-.84358887E-08
-.17454190E-05	-.61060311E-07	.22204943E-07	.56177629E-06	.13463461E-06
-.14755869E-07	-.18433634E-12	-.72183338E-07	.90190096E-07	-.75307473E-13
.36174635E-02	.19730933E-01	-.68628116E-06	.19571357E-01	-.43996180E-02
-.78227017E-06	.96672133E-06	-.11372652E-05	-.81782833E-13	.37524982E-05
-.34633772E-06	.73163584E-12	-.14240023E-05	.16913358E-05	.85314857E-12
-.30146541E-08	.35978002E-08	-.45661113E-06	-.42909184E-08	-.19153162E-08
.50616539E-07	-.12756037E-01	-.20183313E-01	-.54931006E-07	.20181394E-01
-.12759081E-01	.42808564E-07	.36247494E-05	-.29293728E-06	-.11631316E-12
-.31447785E-08	-.59196241E-08	.10223336E-07	-.49032229E-08	.29885627E-08
.83085912E-07	.26910936E-01	.53138454E-01	-.10396571E-06	-.53141657E-01
.26904645E-01	-.94708623E-07	-.13404742E-06	.82364180E-06	-.18701826E-02
-.99446352E-07	.60651059E-06	.17943828E-01	.21846001E-01	-.12358662E+00
-.57679267E-07	.56448434E-07	-.24611815E-06	-.73965692E-06	-.62194659E-07
.47712538E-06	.76244129E-07	.22295994E-07	.84358887E-08	.17454190E-05
.47263847E-08	-.24842569E-07	-.74612173E-02	.33702520E-07	.52587698E-08
-.99165381E+00	-.24130997E-02	.27251892E-01	-.20230691E-06	.42383207E-07
-.11484143E-07	.90215619E-06	-.40538688E-08	.59415338E-07	.40772390E-06
-.88506639E-09	-.26291127E-07	.93122118E-07	-.70112029E-06	.18615170E-06
-.27093746E-06	-.11513953E+00	.10016519E+01	.10444111E-07	.66967927E-06
-.22081894E-06	.29618344E-06	-.36225913E-08	.85213715E-08	-.40353386E-01
-.80313089E-08	-.50214583E-08	.13026438E+00	-.79053746E-07	.70869914E-06
.84282940E-07	.96353235E-10	.81235041E-06	.18225686E-07	.92446699E-02
.36511561E+00	-.12675867E-07	-.57668967E-08	-.84437859E-08	-.19320351E-01
-.83112891E-08	.55592945E-08	-.12118342E+00	.37021885E-07	-.17801169E-06
-.12499195E-06	-.55451004E-07	-.26193636E-06	.18332552E-07	-.80726494E-06
-.22112481E-06	-.17620561E-01	-.58761898E-06	-.15995717E-06	-.31010888E-02
.12080850E+00	.34003255E-01	.19362683E-07	.24294989E-06	.44164116E-07
-.23229657E-05	-.43215597E-06	-.10569704E-06	-.33350487E-07	.61060311E-07
-.22204943E-07	-.56177629E-06	-.33702520E-07	-.52587698E-08	.99165381E+00
.19757764E-07	.81710904E-08	-.74615305E-02	-.26877854E-01	-.51057423E-02
.67961445E-07	.12974058E-06	-.90406751E-08	-.26684890E-06	-.65884970E-07
.26442837E-06	.13464373E-05	.30067542E-06	-.20275997E-08	.86886469E-07
-.21444915E-05	.11187428E-06	-.77099669E-07	-.98527966E+00	-.21397787E+00
-.14263427E-08	.20740004E-05	-.23288741E-06	.46545419E-07	.87483772E-09
.17211154E-07	-.12561504E+00	-.15869406E-07	.14981146E-08	-.53077809E-01
-.69826092E-06	-.93248306E-07	.23220378E-06	-.86409724E-06	-.81421980E-07
.11449558E-06	-.36422996E+00	-.27036148E-01	.14001264E-08	.48725385E-08
.12206505E-07	-.11866768E+00	.12399628E-07	-.47190946E-08	.31250391E-01
.23088390E-06	-.32957092E-07	-.37125093E-06	.35360159E-06	.28254188E-07
-.38520272E-07	.53324649E-02	.28274991E-01	.60964083E-07	-.28423613E-01
.44735140E-02	-.26039509E-08	.45282224E-07	-.61839009E-08	-.75797873E-14
.35178955E-09	.14722675E-07	.16092113E-06	.71735340E-08	.38147924E-09
-.10918412E-07	-.13463461E-06	.14755869E-07	.18433634E-12	.24130997E-02
-.27251892E-01	.20230691E-06	.26877854E-01	.51057423E-02	-.67961445E-07
-.19610946E-09	-.12793244E-08	-.40284160E-14	-.83006278E-07	.16727198E-07
-.31503409E-13	-.12027390E-08	-.79489702E-08	-.94373911E-07	-.70395759E-09
-.24600259E-09	-.61037343E-08	.20879089E-06	-.14299961E-07	-.29220077E-13
-.15107758E-06	.17930787E-07	.35600382E-13	-.18459429E-06	.73257490E-07

.32197615E-13	-.11934809E-01	-.24773363E-01	-.28562365E-07	.24773764E-01
-.11933949E-01	.10299928E-08	.93398544E-10	.13727412E-09	-.23093011E-07
-.54977989E-09	.38611032E-09	-.12072820E-07	-.34175860E-07	.90726267E-08
.25781137E-13	-.30017386E-01	-.48004147E-01	-.21394263E-07	-.48004340E-01
.30017176E-01	-.16597444E-08	.15204283E-09	-.22344016E-10	.41855726E-07
.19779770E-08	-.13203123E-08	.89135235E-08	-.18974310E-07	.16027134E-07
-.26374269E-06	-.16609008E-06	-.45472414E-07	-.37293498E-07	-.13743203E-06
-.22855908E-08	.88236331E-13	-.65717217E-02	-.49474668E-01	-.21395490E-06
.49455263E-01	-.67166526E-02	.25146107E-06	.72183338E-07	-.90190096E-07
.75307473E-13	-.42383207E-07	.11484143E-07	-.90215619E-06	-.12974058E-06
.90406751E-08	.26684890E-06	.83006278E-07	-.16727198E-07	.31503409E-13
.10960857E-07	-.12663272E-07	-.12636246E-13	-.19959259E-02	.72617544E-01
.79350189E-07	.72639356E-01	-.89484432E-03	.11343359E-06	-.16459085E-06
.21258826E-06	.17755656E-12	.50741177E-06	-.65700277E-07	-.13810761E-12
.12668197E-06	-.19034335E-06	-.24898461E-12	.48485096E-09	-.38632258E-09
.20325780E-06	.53522249E-09	.18948680E-10	.27623676E-08	.84150598E-02
.17168433E-01	.34115338E-07	-.17167179E-01	.84177208E-02	-.13940941E-07
-.51059035E-07	-.57298172E-07	.20698406E-13	.94233533E-10	.50069943E-09
.11013082E-06	.50976879E-11	-.19275352E-09	.15874235E-08	-.41887505E-02
-.31354146E-01	-.46431865E-07	.31354628E-01	-.41849538E-02	.36824273E-07
-.21157972E-08	.24413690E-06	.10930903E-06	.10498110E-06	-.45860445E-06
.93834662E-06	.28600792E-09	-.22856711E-07	.87464909E-07	.14410719E-08
.40903978E-08	-.60441216E-01	.93566548E-09	.57381558E-08	.53707875E+00
-.36174635E-02	-.19730933E-01	.68628116E-06	.40538688E-08	-.59415338E-07
-.40772390E-06	.65884970E-07	-.26442837E-06	-.13464373E-05	.12027390E-08
.79489702E-08	.94373911E-07	.19959259E-02	-.72617544E-01	-.79350189E-07
-.70696657E-10	.59061577E-09	.15406909E-02	-.20017513E-08	-.22674296E-08
.18271839E+00	-.29420640E-01	.35553316E+00	.10890627E-08	-.22036796E-08
.72972846E-07	-.18535266E-06	.15383984E-02	-.28931664E+00	.30106500E-09
.35186887E-07	-.34894224E-06	-.12497649E-08	-.41746864E-07	.22875467E-07
.45437189E-07	-.42673819E-09	-.78136072E-09	.29073755E-01	.83848781E-09
-.30068531E-10	-.41762028E-01	.54019335E-08	-.52857311E-07	.69439023E-07
.39767875E-07	.76296204E-08	-.21121434E-08	.11553120E-06	.45920329E-07
-.21718772E-07	.44647683E-09	.16416114E-08	-.28098883E-01	-.16609482E-08
.44578552E-09	.79066663E-01	.24235997E-06	-.10887613E-07	.13773702E-06
-.45908021E-06	-.88219631E-07	-.18403367E-06	.79568074E-08	-.51110757E-09
-.14175266E-07	.11126326E-08	-.49737407E-08	.53923648E+00	.90587906E-08
-.40903232E-08	.40597617E-01	-.19571357E-01	.43996180E-02	.78227017E-06
.88506639E-09	.26291127E-07	-.93122118E-07	-.30067542E-06	.20275997E-08
-.86886469E-07	.70395759E-09	.24600259E-09	.61037343E-08	-.72639356E-01
.89484432E-03	-.11343359E-06	.20017513E-08	.22674296E-08	-.18271839E+00
-.15690317E-08	.10989807E-09	.15406299E-02	.35642111E+00	.15252056E-01
-.15551538E-09	.11525644E-08	.22841308E-08	.53271028E-07	-.28914783E+00
.99735803E-02	-.80529120E-11	-.39209234E-06	.26942708E-07	-.40357060E-08
-.23699116E-07	-.12256696E-08	.39578955E-08	.13718954E-08	.23672818E-08
-.42889921E-01	-.19728023E-08	.12993543E-08	-.27395597E-01	.10482756E-07
-.36015513E-08	.59618938E-07	-.98494637E-07	.30215091E-07	.83151351E-09
.11154142E-06	-.12729912E-07	-.22012824E-08	-.20575968E-08	-.54136933E-08
.80118470E-01	.54141545E-08	-.20376560E-08	.24921274E-01	.74355275E-06
-.86344820E-06	.86348556E-08	.78571358E-05	.80752560E-06	.22489195E-06
.23010227E-06	.98727685E-07	-.43416653E-13	.94714179E-01	.64899273E+00
.34678836E-08	-.64871410E+00	.96615212E-01	.60262836E-09	-.96672133E-06
.11372652E-05	.81782833E-13	.70112029E-06	-.18615170E-06	.27093746E-06
.21444915E-05	-.11187428E-06	.77099669E-07	-.20879089E-06	.14299961E-07
.29220077E-13	.16459085E-06	-.21258826E-06	-.17755656E-12	.29420640E-01
-.35553316E+00	-.10890627E-08	-.35642111E+00	-.15252056E-01	.15551538E-09
.19702911E-08	.17067919E-09	-.67397229E-14	.43502667E-06	.23008021E-06
-.18534110E-15	-.31921334E-09	-.49233010E-09	-.98795752E-14	-.46272789E-08
.32747580E-08	.41693501E-08	-.86543027E-08	.51209400E-08	-.21513879E-08
-.12962772E+00	-.22610792E+00	-.55780767E-10	.22608848E+00	-.12966222E+00
-.46893542E-10	-.63686977E-06	.54634427E-06	.37138548E-15	.86753266E-08
.74221774E-08	.46945470E-08	.16797908E-07	-.91574736E-08	.19556552E-08
.19954144E+00	.51982556E+00	.11311457E-09	-.51984922E+00	.19947944E+00
.51066096E-10	.10594211E+00	.72922176E-01	-.12741219E-07	-.76105503E-01
.10368437E+00	-.15769748E-08	.24898360E-06	-.91483883E-07	.77664092E-13
.10559694E-07	.39960159E-06	-.37782460E-06	.18891624E-06	.98396479E-08
-.89202189E-07	-.37524982E-05	.34633772E-06	-.73163584E-12	.11513953E+00
-.10016519E+01	-.10444111E-07	.98527966E+00	.21397787E+00	.14263427E-08
.15107758E-06	-.17930787E-07	-.35600382E-13	-.50741177E-06	.65700277E-07
.13810761E-12	.22036796E-08	-.72972846E-07	.18535266E-06	-.11525644E-08
-.22841308E-08	-.53271028E-07	-.43502667E-06	-.23008021E-06	.18534110E-15

-.12392972E-07	-.12119306E-08	-.18085362E-13	-.25448515E-06	-.24080342E-06
-.72100480E-15	.42365812E-01	.22743214E+00	.53395066E-09	-.22743389E+00
.42358362E-01	.13756098E-09	-.34009417E-09	-.36617465E-08	-.44502412E-08
.50488788E-08	-.25689226E-08	.32032115E-08	.14881036E-07	.20788290E-08
-.53416876E-14	.49700530E-01	.27168256E+00	.17278504E-09	.27168278E+00
-.49698521E-01	-.46204715E-10	-.72402280E-09	-.51155317E-09	.66103844E-08
-.10387562E-07	.27226537E-08	-.73095770E-08	.80583169E-06	-.12968028E-05
.14501437E-06	.10568617E-04	-.57565891E-06	-.76217949E-06	.45284969E-06
-.42741722E-07	.21249170E-12	-.13940018E+00	-.12146079E+01	.12958433E-08
.12141936E+01	-.14295856E+00	-.23050185E-09	.14240023E-05	-.16913358E-05
-.85314857E-12	-.66967927E-06	.22081894E-06	-.29618344E-06	-.20740004E-05
.23288741E-06	-.46545419E-07	.18459429E-06	-.73257490E-07	-.32197615E-13
-.12668197E-06	.19034335E-06	.24898461E-12	-.15383984E-02	.28931664E+00
-.30106500E-09	.28914783E+00	-.99735803E-02	.80529120E-11	.31921334E-09
.49233010E-09	.98795752E-14	.25448515E-06	.24080342E-06	.72100480E-15
.80857846E-09	-.65913199E-09	-.89837874E-14	-.40276693E-08	.23299565E-08
.33531355E-09	-.74204357E-08	.35521019E-08	.62833350E-08	-.82095560E-01
-.12224359E+00	-.26190706E-11	.12223122E+00	-.82113856E-01	-.75550354E-12
-.49434274E-06	.52138355E-06	-.36084625E-15	.72258733E-08	.45094717E-08
.82984545E-09	.11398262E-07	-.86245755E-08	-.84823258E-08	.20012965E+00
.34933873E+00	.29523672E-11	-.34936258E+00	.20008846E+00	-.35514320E-11
.91143541E-07	-.15942143E-06	.12557840E+00	.74044170E-07	-.11391547E-06
.46976639E+00	.13278546E-01	.52285061E-01	-.14719014E-06	-.19372121E-06
-.13219075E-05	-.14943658E-08	.14209128E-05	-.23416354E-06	-.35761913E-07
.30146541E-08	-.35978002E-08	.45661113E-06	.36225913E-08	-.85213715E-08
.40353386E-01	-.87483772E-09	-.17211154E-07	.12561504E+00	.11934809E-01
.24773363E-01	.28562365E-07	-.48485096E-09	.38632258E-09	-.20325780E-06
-.35186887E-07	.34894224E-06	.12497649E-08	.39209234E-06	-.26942708E-07
.40357060E-08	.46272789E-08	-.32747580E-08	-.41693501E-08	-.42365812E-01
-.22743214E+00	-.53395066E-09	.40276693E-08	-.23299565E-08	-.33531355E-09
-.13190608E-09	-.42992791E-09	.53549523E-03	.44221408E-09	-.15144278E-09
-.50250104E-02	-.53621168E-07	-.78323735E-07	-.76419772E-10	.67488837E-07
-.40301963E-07	.71900559E-10	-.38245326E-02	.95707833E-02	.28472227E-09
-.26263013E-09	-.59806850E-09	.30586106E-02	-.60005167E-09	.27669342E-09
.65749091E-02	.13037445E-06	.21701737E-06	.12705909E-09	-.21430064E-06
.12189418E-06	-.18933107E-09	.16085783E-06	.84422487E-07	-.47379413E+00
.12058674E-06	.75683469E-07	.13985513E+00	-.52285564E-01	.13276810E-01
.63399074E-08	-.80698553E-07	.19053734E-06	-.77887080E-07	-.15420580E-06
.19440207E-07	-.14128991E-08	.42909184E-08	.19153162E-08	-.50616539E-07
.80313089E-08	.50214583E-08	-.13026438E+00	.15869406E-07	-.14981146E-08
.53077809E-01	-.24773764E-01	.11933949E-01	-.10299928E-08	-.53522249E-09
-.18948680E-10	-.27623676E-08	.41746864E-07	-.22875467E-07	-.45437189E-07
.23699116E-07	.12256696E-08	-.39578955E-08	.86543027E-08	-.51209400E-08
.21513879E-08	.22743389E+00	-.42358362E-01	-.13756098E-09	.74204357E-08
-.35521019E-08	-.62833350E-08	-.44221408E-09	.15144278E-09	.50250104E-02
-.10011899E-08	.39672401E-09	.53548366E-03	.35302623E-07	.45619868E-07
-.18324191E-09	-.58945067E-07	.24482274E-07	-.14363279E-09	-.95706411E-02
-.38248253E-02	.52950837E-10	.80178997E-09	.17350601E-08	.65747891E-02
.17209949E-08	-.80376640E-09	-.30587738E-02	-.65962710E-07	-.12765379E-06
.24445245E-09	.13611625E-06	-.63215067E-07	.27202374E-09	.16763984E-06
.73009900E-06	-.48745525E-06	-.10506104E-05	-.54053200E-06	-.30253741E-05
.26217801E-08	.39483112E-08	-.92799969E-07	-.39680923E-08	-.64423900E-08
-.19692464E-01	-.11873660E-07	-.19292084E-07	-.96879863E-04	.12756037E-01
.20183313E-01	.54931006E-07	.79053746E-07	-.70869914E-06	-.84282940E-07
.69826092E-06	.93248306E-07	-.23220378E-06	-.93398544E-10	-.13727412E-09
.23093011E-07	-.84150598E-02	-.17168433E-01	-.34115338E-07	.42673819E-09
.78136072E-09	-.29073755E-01	-.13718954E-08	-.23672818E-08	.42889921E-01
.12962772E+00	.22610792E+00	.55780767E-10	.34009417E-09	.36617465E-08
.44502412E-08	.82095560E-01	.12224359E+00	.26190706E-11	.53621168E-07
.78323735E-07	.76419772E-10	-.35302623E-07	-.45619868E-07	.18324191E-09
.16412533E-11	.21384164E-11	.32021163E-03	.58936241E-11	-.14505988E-10
-.33385669E-02	-.42306378E-10	-.13863650E-08	.83012671E-08	-.56730240E-07
-.96467007E-07	-.10535633E-09	-.91711930E-07	.55460535E-07	-.51525169E-09
-.43381873E-11	-.92974491E-11	-.29258756E-02	.76083731E-11	.16981023E-11
.72526267E-02	.27553639E-06	.28304144E-05	.20161874E-06	-.21515236E-05
-.12619873E-06	-.20116967E-05	-.35017562E-08	.20853839E-08	-.83171247E-07
.67860925E-08	-.11108030E-08	.36522737E-04	.16434235E-07	-.11524456E-07
-.19691541E-01	-.20181394E-01	.12759081E-01	-.42808564E-07	-.96353235E-10
-.81235041E-06	-.18225686E-07	.86409724E-06	.81421980E-07	-.11449558E-06
.54977989E-09	-.38611032E-09	.12072820E-07	.17167179E-01	-.84177208E-02
.13940941E-07	-.83848781E-09	.30068531E-10	.41762028E-01	.19728023E-08

-.12993543E-08	.27395597E-01	-.22608848E+00	.12966222E+00	.46893542E-10
-.50488788E-08	.25689226E-08	-.32032115E-08	-.12223122E+00	.82113856E-01
.75550354E-12	-.67488837E-07	.40301963E-07	-.71900559E-10	.58945067E-07
-.24482274E-07	.14363279E-09	-.58936241E-11	.14505988E-10	.33385669E-02
-.45134366E-09	.30239391E-09	.32020344E-03	.31906173E-09	.34199546E-11
-.81669645E-08	-.30329414E-06	-.66271809E-06	-.35363609E-09	-.66144997E-06
.30804574E-06	.20159786E-09	-.57170319E-09	-.11035564E-08	-.72527212E-02
.10976139E-08	-.57328140E-09	-.29238966E-02	.21301848E+00	.18980035E+01
.16449225E-07	-.19035792E+01	.15542683E+00	.27743136E-08	.65246642E-06
-.17160470E-06	.41382889E-12	.71710619E-08	.46661594E-06	-.20025118E-06
.22074571E-06	.15404011E-07	.27221783E-06	-.36247494E-05	.29293728E-06
.11631316E-12	-.92446699E-02	-.36511561E+00	.12675867E-07	.36422996E+00
.27036148E-01	-.14001264E-08	.34175860E-07	-.90726267E-08	-.25781137E-13
.51059035E-07	.57298172E-07	-.20698406E-13	-.54019335E-08	.52857311E-07
-.69439023E-07	-.10482756E-07	.36015513E-08	-.59618938E-07	.63686977E-06
-.54634427E-06	-.37138548E-15	-.14881036E-07	-.20788290E-08	.53416876E-14
.49434274E-06	-.52138355E-06	.36084625E-15	.38245326E-02	-.95707833E-02
-.28472227E-09	.95706411E-02	.38248253E-02	-.52950837E-10	.42306378E-10
.13863650E-08	-.83012671E-08	-.31906173E-09	-.34199546E-11	.81669645E-08
-.87485007E-08	-.13865777E-08	.21238779E-14	-.17696591E+00	-.39083612E+00
-.84602464E-10	-.39083720E+00	.17696374E+00	.30775127E-10	.12256099E-08
.79443691E-09	.63405973E-08	.15032889E-07	-.80204827E-08	.24197572E-08
.15146456E-06	.22667613E-06	.27864015E+00	.12645160E-06	.20146267E-06
.74812742E+00	.23320671E-01	.71358750E-01	-.15696020E-06	-.65869035E-07
-.31119132E-06	.19170180E-07	.28954207E-06	-.78314182E-07	-.29898828E-08
.31447785E-08	.59196241E-08	-.10223336E-07	.57668967E-08	.84437859E-08
.19320351E-01	-.48725385E-08	-.12206505E-07	.11866768E+00	.30017386E-01
.48004147E-01	.21394263E-07	-.94233533E-10	-.50069943E-09	-.11013082E-06
-.39767875E-07	-.76296204E-08	.21121434E-08	.98494637E-07	-.30215091E-07
-.83151351E-09	-.86753266E-08	-.74221774E-08	-.46945470E-08	-.49700530E-01
-.27168256E+00	-.17278504E-09	-.72258733E-08	-.45094717E-08	-.82984545E-09
.26263013E-09	.59806850E-09	-.30586106E-02	-.80178997E-09	-.17350601E-08
-.65747891E-02	.56730240E-07	.96467007E-07	.10535633E-09	.30329414E-06
.66271809E-06	.35363609E-09	.17696591E+00	.39083612E+00	.84602464E-10
.34515937E-11	.11639133E-10	.11823240E-03	.78122412E-12	-.14089096E-10
-.72836582E-02	-.46789915E-08	-.15892413E-07	.65356843E-10	.31383227E-07
.10485630E-07	.42666551E-09	.22686122E-06	-.15001301E-06	.75692354E+00
.20000508E-06	-.12631014E-06	-.30143385E+00	.71358882E-01	-.23320214E-01
.38814806E-07	.48891040E-08	.41439984E-06	.18152134E-07	-.42591726E-06
.27558297E-07	.32855064E-08	.49032229E-08	-.29885627E-08	-.83085912E-07
.83112891E-08	-.55592945E-08	.12118342E+00	-.12399628E-07	.47190946E-08
-.31250391E-01	.48004340E-01	-.30017176E-01	.16597444E-08	-.50976879E-11
.19275352E-09	-.15874235E-08	-.11553120E-06	-.45920329E-07	.21718772E-07
-.11154142E-06	.12729912E-07	.22012824E-08	-.16797908E-07	.91574736E-08
-.19556552E-08	-.27168278E+00	.49698521E-01	.46204715E-10	-.11398262E-07
.86245755E-08	.84823258E-08	.60005167E-09	-.27669342E-09	-.65749091E-02
-.17209949E-08	.80376640E-09	.30587738E-02	.91711930E-07	-.55460535E-07
.51525169E-09	.66144997E-06	-.30804574E-06	-.20159786E-09	.39083720E+00
-.17696374E+00	-.30775127E-10	-.78122412E-12	.14089096E-10	.72836582E-02
-.14618963E-09	.69521649E-10	.11823684E-03	-.73228149E-08	-.29478674E-07
.22679544E-09	.44642344E-07	-.22809491E-07	.59107460E-10	-.85227134E-07
-.54382657E-06	.11012196E-05	.10593951E-05	.15030137E-05	.77536846E-05
-.47261019E-08	-.11104159E-07	.25209767E-06	.76837879E-08	.16366625E-07
.11419001E+00	.22910605E-07	.48721700E-07	.94812449E-01	-.26910936E-01
-.53138454E-01	.10396571E-06	-.37021885E-07	.17801169E-06	.12499195E-06
-.23088390E-06	.32957092E-07	.37125093E-06	-.15204283E-09	.22344016E-10
-.41855726E-07	.41887505E-02	.31354146E-01	.46431865E-07	-.44647683E-09
-.16416114E-08	.28098883E-01	.20575968E-08	.54136933E-08	-.80118470E-01
-.19954144E+00	-.51982556E+00	-.11311457E-09	.72402280E-09	.51155317E-09
-.66103844E-08	-.20012965E+00	-.34933873E+00	-.29523672E-11	-.13037445E-06
-.21701737E-06	-.12705909E-09	.65962710E-07	.12765379E-06	-.24445245E-09
.43381873E-11	.92974491E-11	.29258756E-02	.57170319E-09	.11035564E-08
.72527212E-02	-.12256099E-08	-.79443691E-09	-.63405973E-08	.46789915E-08
.15892413E-07	-.65356843E-10	.73228149E-08	.29478674E-07	-.22679544E-09
-.20205244E-11	-.39891324E-11	.87155679E-04	.84364044E-11	.86915796E-11
.68614717E-02	-.35436475E-07	-.14708492E-05	-.62332048E-06	-.10054546E-06
.52218327E-06	.39275247E-05	.82271192E-08	-.34017979E-08	.17927404E-06
-.16399263E-07	.73058140E-08	-.94493068E-01	-.48349038E-07	.22872252E-07
.11390138E+00	.53141657E-01	-.26904645E-01	.94708623E-07	.55451004E-07
.26193636E-06	-.18332552E-07	-.35360159E-06	-.28254188E-07	.38520272E-07
-.19779770E-08	.13203123E-08	-.89135235E-08	-.31354628E-01	.41849538E-02

```
 -.36824273E-07  .16609482E-08 -.44578552E-09 -.79066663E-01 -.54141545E-08
  .20376560E-08 -.24921274E-01  .51984922E+00 -.19947944E+00 -.51066096E-10
  .10387562E-07 -.27226537E-08  .73095770E-08  .34936258E+00 -.20008846E+00
  .35514320E-11  .21430064E-06 -.12189418E-06  .18933107E-09 -.13611625E-06
  .63215067E-07 -.27202374E-09 -.76083731E-11 -.16981023E-11 -.72526267E-02
 -.10976139E-08  .57328140E-09  .29238966E-02 -.15032889E-07  .80204827E-08
 -.24197572E-08 -.31383227E-07 -.10485630E-07 -.42666551E-09 -.44642344E-07
  .22809491E-07 -.59107460E-10 -.84364044E-11 -.86915796E-11 -.68614717E-02
 -.10375733E-09  .53480837E-10  .87160403E-04
 kdyic1
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00
 rvtor1
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00
 svtor2
```

```
.00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
.00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
.00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
(and more)
```

A.4 **Concept 3 Definitions and TREETOPS files**

Sensor Definitions
Actuator Definitions
Interconnect Definitions
TREETOPS files:
- Summer Solstice (SS): .int, .lin, los.dat, solar_pressure.dat, excerpt of .flx
- Vernal Equinox (VE): .int
- Autumnal Equinox (AE): .int
- Winter Solstice (WS): .int

Table A.4.1 Sensor Definitions (Concept 3)

Global Sensor Output No.	TREETOPS Sensor Designation	Local Sensor Output No.	Sensor Mount Loc.	Type	used	DOF
RP1	SE 1	1	B2-N2	Earth Target (ET) (LOS Along X^{B2})		Pitch (Y^{B2}) Error – Overall System
RP2	SE 1	2	B2-N2			Yaw (Z^{B2}) Error – Overall System
RP3	SE 2	1	B2-N2	Star Tracker (ST) (LOS Along Z^{B2})		Roll (X^{B2}) Error – Overall System
RP4	SE 2	2	B2-N2			Not used in control (Pitch (Y^{B2}) Error)
RP5	SE 2	3	B2-N2			Not used in control (Validity Flag on(1) off(0))
RP6	SE 3	1	B3-N2	LOS Sensor (L) (LOS Along $-Y^{1}$) (Negative Polar Axis) see .los file		Roll (X^{B3}) Error – Upper Clamshell
RP7	SE 3	2	B3-N2			Pitch (Y^{B3}) Error – Upper Clamshell
RP8	SE 3	3	B3-N2			Yaw (Z^{B3}) Error – Upper Clamshell
RP9	SE 3	4	B3-N2			Not used in control
RP10	SE 3	5	B3-N2			Not used in control
RP11	SE 3	6	B3-N2			Not used in control
RP12	SE 3	7	B3-N2			Not used in control
RP13	SE 4	1	B4-N2	LOS Sensor (L) (LOS Along $+Y^{1}$) (Positive Polar Axis) see .los file		Roll (X^{B4}) Error – Lower Clamshell
RP14	SE 4	2	B4-N2			Pitch (Y^{B4}) Error – Lower Clamshell
RP15	SE 4	3	B4-N2			Yaw (Z^{B4}) Error – Lower Clamshell
RP16	SE 4	4	B4-N2			Not used in control
RP 17	SE 4	5	B4-N2			Not used in control
RP 18	SE 4	6	B4-N2			Not used in control
RP 19	SE 4	7	B4-N2			Not used in control
RP 20	SE 5	1	B2-N5	Star Tracker (ST) (LOS Along $-X^{B2}$) (Towards Sun)		Not used in control (Yaw (Z^{B2}) Error
RP 21	SE 5	2	B2-N5			Not used in control (Pitch (Y^{B2}) Error)
RP 22	SE 5	3	B2-N5			Validity Flag on(1) off(0) Used for Rad Pres Disturb
RP 23	SE 6	1	B2-N2	3 Axis Accelerometer (A3) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B2})
RP 24	SE 6	2	B2-N2			Not used in control, For Output Only, ACCEL (Y^{B2})
RP 25	SE 6	3	B2-N2			Not used in control, For Output Only, ACCEL (Z^{B2})
RP 26	SE 7	1	B2-N2	1 Axis Accelerometer (AC) with gravity removed		Not used in control, For Output Only, ACCEL (X^{B2})

Table A.4.2 Actuator Definitions (Concept 3)

Global Actuator Input No.	TREETOPS Actuator Designation	Sensor Mount Loc.	Type	DOF
UP 1	AC 1	B2-N2	Moment Actuator (MO)*	Pitch (Y^{B2}) Ext. Torque – Overall System
UP 2	AC 2	B2-N2	Moment Actuator (MO)*	Yaw (Z^{B2}) Ext. Torque - Overall System
UP 3	AC 3	B2-N2	Moment Actuator (MO)*	Roll (X^{B2}) Ext. Torque - Overall System
UP 4	AC 4	B3-N2	Moment Actuator (MO)*	Roll (X^{B3}) Ext. Torque – Upper Clamshell
UP 5	AC 5	B3-N2	Moment Actuator (MO)*	Pitch (Y^{B3}) Ext. Torque – Upper Clamshell
UP 6	AC 6	B3-N2	Moment Actuator (MO)*	Yaw (Z^{B3}) Ext. Torque – Upper Clamshell
UP 7	AC 7	B4-N2	Moment Actuator (MO)*	Roll (X^{B4}) Ext. Torque - Lower Clamshell
UP 8	AC 8	B4-N2	Moment Actuator (MO)*	Pitch (Y^{B4}) Ext. Torque – Lower Clamshell
UP 9	AC 9	B4-N2	Moment Actuator (MO)*	Yaw (Z^{B4}) Ext. Torque - Lower Clamshell
UP 10	AC 10	B2-N5	Reaction Jet (J) Radiation Pressure Disturbance	$-X^{B2}$ Force at Central Body Transmitter

Notes:
* Moment Actuator (MO) in TREETOPS is an External Moment applied to a Body (Reacts against Space) Used in Control

Table A.4.3:
Interconnect Data and Significant Parameters for TREETOPS Continuous Matrix (CM) Controller (Concept 3)

Interconnect Data						Significant Parameters in Continuous Matrix (CM) Controller in .lin file xdot = Ax + Bu y = Cx + Du			
Inter-connect	Description	S C C A	S No. C No. C No. A No.	S Out No. C In No. C Out No. A In No.	Gain N-m or N	Subset of A Matrix	Subset of B Matrix	Subset of C Matrix ω^2 $2\zeta\omega$	Subset of D Matrix
IC 1	Pitch (Y^{B2}) of Overall System	S	1	1	4.41E13	0. 1.	0	.000025 .007	0
		C	1	1					
IC 2		C	1	1	1.0	-1. -1.4	1		
		A	1	1					
IC 3	Yaw (Z^{B2}) of Overall System	S	1	2	1.67E12	0. 1.	0	.000025 .007	0
		C	1	2					
IC 4		C	1	2	1.0	-1. -1.4	1		
		A	2	1					
IC 5	Roll (X^{B2}) of Overall System	S	2	1	4.31E13	0. 1.	0	.000025 .007	0
		C	1	3					
IC 6		C	1	3	1.0	-1. -1.4	1		
		A	3	1					
IC 7	Roll (X^{B3}) of Upper Clamshell	S	3	1	1.7E12	0. 1.	0	.0001 .014	0
		C	1	4					
IC 8		C	1	4	1.0	-1. -1.4	1		
		A	4	1					
IC 9	Pitch (Y^{B3}) of Upper Clamshell	S	3	2	1.7E12	0. 1.	0	.0001 .014	0
		C	1	5					
IC 10		C	1	5	1.0	-1. -1.4	1		
		A	5	1					
IC 11	Yaw (Z^{B3}) of Upper Clamshell	S	3	3	3.4E12	0. 1.	0	.0001 .014	0
		C	1	6					
IC 12		C	1	6	1.0	-1. -1.4	1		
		A	6	1					
IC 13	Roll (X^{B4}) of Lower Clamshell	S	4	1	1.7E12	0. 1.	0	.0001 .014	0
		C	1	7					
IC 14		C	1	7	1.0	-1. -1.4	1		
		A	7	1					
IC 15	Pitch (Y^{B4}) of Lower Clamshell	S	4	2	1.7E12	0. 1.	0	.0001 .014	0
		C	1	8					
IC 16		C	1	8	1.0	-1. -1.4	1		
		A	8	1					
IC 17	Yaw (Z^{B4}) of Lower Clamshell	S	4	3	3.4E12	0. 1.	0	.0001 .014	0
		C	1	9					
IC 18		C	1	9	1.0	-1. -1.4	1		
		A	9	1					
IC 19	$-X^{B2}$ of Radiation Pres Disturb	S	5	3	7.0				
		A	10	1					

isc3_flex_sol.int (Concept 3) Summer Solstice

```
TREETOPS REV 10P2  4/10/00

          SIM CONTROL
                                                                      ISC MODEL, THIRD VERSION
 1 SI   0 Title                                                       100000
 2 SI   0 Simulation stop time                                        20
 3 SI   0 Plot data interval                                          R
 4 SI   0 Integration type (R,S,U, OR V)                              .1
 5 SI   0 Step size (sec)
 6 SI   0 Sandia ODE solver absolute and relative error
 7 SI   0 RK78 ODE solver absolute error and first step size
 8 SI   0 Linearization option  (L,Z or N)                            N
 9 SI   0 Restart option        (Y/N)                                 N
10 SI   0 Contact force computation option      (Y/N)                 Y
11 SI   0 Constraint force computation option   (Y/N)                 N
12 SI   0 Small angle speedup option (All,Bypass,First,Nth)           A
13 SI   0 Mass matrix speedup option (All,Bypass,First,Nth)           A
14 SI   0 Non-Linear  speedup option (All,Bypass,First,Nth)           A
15 SI   0 Constraint  speedup option (All,Bypass,First,Nth)           A
16 SI   0 Constraint stabilization option  (Y/N)                      N
17 SI   0 Stabilization epsilon

          GENGRAV

18 GG   0 Gravity, earth sphere/nonsphere/user (S/N/U)?               N
19 GG   1 Input gravity constants:  GME, ERAD, EMASS
20 GG   1 Spherical or Nonspherical (S/N)?
21 GG   1 Gravity Potential Harmonics J2,J3,J4
22 GG   0 English (ft-slug-s) or metric (m-kg-s)    (E/M)?            M
23 GG   0 Day, Month, Year,                                           21 6 2020
24 GG   0 GMT @ sim time 0 (minutes past midnight,                    0
25 GG   0 Solar Pressure forces Y/N?                                  Y
26 GG   0 Input new data for aero model? (Y/N)                        N
27 GG   1   Solar flux F10 for aero model
28 GG   1   Solar flux, 81 day average F10B
29 GG   1   Geomagnetic index, GEAP

          BODY

30 BO   1 Body ID number                                              1
31 BO   1 Type (Rigid,Flexible,NASTRAN)                               F
32 BO   1 Number of modes                                             24
33 BO   1 Modal calculation option (0, 1 or 2)                        2
34 BO   1 Foreshortening option (Y/N)
35 BO   1 Model reduction method (NO,MS,MC,CC,QM,CV)
36 BO   1 NASTRAN data file FORTRAN unit number (40 - 60)
37 BO   1 Number of augmented nodes (0 if none)
38 BO   1 Damping matrix option (NS,CD,HL,SD)
39 BO   1 Constant damping ratio
40 BO   1 Low frequency, High frequency ratios
41 BO   1 Mode ID number, damping ratio
42 BO   1 Conversion factors: Length,Mass,Force
43 BO   1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
44 BO   1 Moments of inertia (kg-m2) Ixx,Iyy,Izz                     6.2852173E11 6.2852173E11
6.7057352E8
45 BO   1 Products of inertia (kg-m2) Ixy,Ixz,Iyz                     0 0 0
46 BO   1 Mass (kg)                                                   1.6168633E5
47 BO   1 Number of Nodes                                             4
48 BO   1 Node ID, Node coord. (meters) x,y,z                         1 0 0 0
49 BO   1 Node ID, Node coord. (meters) x,y,z                         2 0 0 0
50 BO   1 Node ID, Node coord. (meters) x,y,z                         3 0 0 3188.8
51 BO   1 Node ID, Node coord. (meters) x,y,z                         4 0 0 -3188.8
52 BO   1 Node ID, Node structual joint ID

53 BO   2 Body ID number                                              2
```

```
 54 BO   2 Type (Rigid,Flexible,NASTRAN)                          R
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz             .8543E12 1.5601E12
1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0 0 0
 69 BO   2 Mass (kg)                                          12666300
 70 BO   2 Number of Nodes                                    5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                     3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                      R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0 0 0
 93 BO   3 Mass (kg)                                          2046600
 94 BO   3 Number of Nodes                                    2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                     4
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                      R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
110 BO   4 Conversion factors: Length,Mass,Force
111 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
112 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz             1.7E12 1.7E12 3.4E12
113 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz            0 0 0
114 BO   4 Mass (kg)                                          2046600
115 BO   4 Number of Nodes                                    2
116 BO   4 Node ID, Node coord. (meters) x,y,z                1 0 0 0
117 BO   4 Node ID, Node coord. (meters) x,y,z                2 0 0 0
118 BO   4 Node ID, Node structual joint ID

           HINGE
```

119	HI	1	Hinge ID number	1
120	HI	1	Inboard body ID, Outboard body ID	0 1
121	HI	1	"p" node ID, "q" node ID	0 2
122	HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123	HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124	HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125	HI	1	L2 unit vector in inboard body coord. x,y,z	
126	HI	1	L2 unit vector in outboard body coord. x,y,z	
127	HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128	HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129	HI	1	Initial rotation angles (deg)	-90 0 90
130	HI	1	Initial rotation rates (deg/sec)	0 0 0.00417807
131	HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132	HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133	HI	1	Null torque angles (deg)	0 0 0
134	HI	1	Number of translation DOFs	3
135	HI	1	First translation unit vector g1	1 0 0
136	HI	1	Second translation unit vector g2	0 1 0
137	HI	1	Third translation unit vector g3	0 0 1
138	HI	1	Initial translation (meters)	0 0 42163421
139	HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140	HI	1	Translation stiffness (newtons/meters)	0 0 0
141	HI	1	Translation damping (newtons/meter/sec)	0 0 0
142	HI	1	Null force translations	0 0 0
143	HI	2	Hinge ID number	2
144	HI	2	Inboard body ID, Outboard body ID	1 2
145	HI	2	"p" node ID, "q" node ID	2 2
146	HI	2	Number of rotation DOFs	0
147	HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148	HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149	HI	2	L2 unit vector in inboard body coord. x,y,z	
150	HI	2	L2 unit vector in outboard body coord. x,y,z	
151	HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152	HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153	HI	2	Initial rotation angles (deg)	0 0 0
154	HI	2	Initial rotation rates (deg/sec)	
155	HI	2	Rotation stiffness (newton-meters/rad)	
156	HI	2	Rotation damping (newton-meters/rad/sec)	
157	HI	2	Null torque angles (deg)	
158	HI	2	Number of translation DOFs	0
159	HI	2	First translation unit vector g1	1 0 0
160	HI	2	Second translation unit vector g2	0 1 0
161	HI	2	Third translation unit vector g3	0 0 1
162	HI	2	Initial translation (meters)	0 0 0
163	HI	2	Initial translation velocity (meters/sec)	
164	HI	2	Translation stiffness (newtons/meters)	
165	HI	2	Translation damping (newtons/meter/sec)	
166	HI	2	Null force translations	
167	HI	3	Hinge ID number	3
168	HI	3	Inboard body ID, Outboard body ID	1 3
169	HI	3	"p" node ID, "q" node ID	3 2
170	HI	3	Number of rotation DOFs	3
171	HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172	HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173	HI	3	L2 unit vector in inboard body coord. x,y,z	
174	HI	3	L2 unit vector in outboard body coord. x,y,z	
175	HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176	HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177	HI	3	Initial rotation angles (deg)	90 0 -123.25
178	HI	3	Initial rotation rates (deg/sec)	-0.004178 0 0
179	HI	3	Rotation stiffness (newton-meters/rad)	0 0 0
180	HI	3	Rotation damping (newton-meters/rad/sec)	0 0 0
181	HI	3	Null torque angles (deg)	0 0 0
182	HI	3	Number of translation DOFs	0
183	HI	3	First translation unit vector g1	1 0 0
184	HI	3	Second translation unit vector g2	0 1 0
185	HI	3	Third translation unit vector g3	0 0 1
186	HI	3	Initial translation (meters)	0 0 0

```
187 HI   3 Initial translation velocity (meters/sec)
188 HI   3 Translation stiffness (newtons/meters)
189 HI   3 Translation damping (newtons/meter/sec)
190 HI   3 Null force translations

191 HI   4 Hinge ID number                                    4
192 HI   4 Inboard body ID, Outboard body ID                  1 4
193 HI   4 "p" node ID, "q" node ID                           4 2
194 HI   4  Number of rotation DOFs                           3
195 HI   4 L1 unit vector in inboard body coord. x,y,z        0 0 1
196 HI   4 L1 unit vector in outboard body coord. x,y,z       0 0 1
197 HI   4 L2 unit vector in inboard body coord. x,y,z
198 HI   4 L2 unit vector in outboard body coord. x,y,z
199 HI   4 L3 unit vector in inboard body coord. x,y,z        0 1 0
200 HI   4 L3 unit vector in outboard body coord. x,y,z       0 1 0
201 HI   4 Initial rotation angles (deg)                      90 0 -33.25
202 HI   4 Initial rotation rates (deg/sec)                   -0.004178 0 0
203 HI   4 Rotation stiffness (newton-meters/rad)             0 0 0
204 HI   4 Rotation damping (newton-meters/rad/sec)           0 0 0
205 HI   4 Null torque angles (deg)                           0 0 0
206 HI   4 Number of translation DOFs                         0
207 HI   4 First translation unit vector   g1                 1 0 0
208 HI   4 Second translation unit vector  g2                 0 1 0
209 HI   4 Third translation unit vector   g3                 0 0 1
210 HI   4 Initial translation (meters)                       0 0 0
211 HI   4 Initial translation velocity (meters/sec)
212 HI   4 Translation stiffness (newtons/meters)
213 HI   4 Translation damping (newtons/meter/sec)
214 HI   4 Null force translations

           SENSOR

215 SE   1 Sensor ID number                                   1
216 SE   1 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ET
217 SE   1 Mounting point body ID, Mounting point node ID     2 2
218 SE   1 Second mounting point body ID, Second node ID
219 SE   1 Input axis unit vector (IA) x,y,z
220 SE   1 Mounting point Hinge index, Axis index
221 SE   1 First focal plane unit vector  (Fp1) x,y,z         0 0 -1
222 SE   1 Second focal plane unit vector (Fp2) x,y,z         0 1 0
223 SE   1 Sun/Star unit vector (Us) x,y,z
224 SE   1 Velocity Aberration Option (Y/N)
225 SE   1 Euler Angle Sequence (1-6)
226 SE   1 CMG ID number and Gimbal number
227 SE   1 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])   6378000 0 0 4.178074D-3

228 SE   2 Sensor ID number                                   2
229 SE   2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) ST
230 SE   2 Mounting point body ID, Mounting point node ID     2 2
231 SE   2 Second mounting point body ID, Second node ID
232 SE   2 Input axis unit vector (IA) x,y,z
233 SE   2 Mounting point Hinge index, Axis index
234 SE   2 First focal plane unit vector  (Fp1) x,y,z         0 -1 0
235 SE   2 Second focal plane unit vector (Fp2) x,y,z         1 0 0
236 SE   2 Sun/Star unit vector (Us) x,y,z                    0 1 0
237 SE   2 Velocity Aberration Option (Y/N)                   N
238 SE   2 Euler Angle Sequence (1-6)
239 SE   2 CMG ID number and Gimbal number
240 SE   2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE   3 Sensor ID number                                   3
242 SE   3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET) L
243 SE   3 Mounting point body ID, Mounting point node ID     3 2
244 SE   3 Second mounting point body ID, Second node ID
245 SE   3 Input axis unit vector (IA) x,y,z                  1 2 3
246 SE   3 Mounting point Hinge index, Axis index
247 SE   3 First focal plane unit vector  (Fp1) x,y,z
248 SE   3 Second focal plane unit vector (Fp2) x,y,z
249 SE   3 Sun/Star unit vector (Us) x,y,z
250 SE   3 Velocity Aberration Option (Y/N)
```

```
251 SE   3 Euler Angle Sequence (1-6)
252 SE   3 CMG ID number and Gimbal number
253 SE   3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE   4 Sensor ID number                                           4
255 SE   4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)         L
256 SE   4 Mounting point body ID, Mounting point node ID             4 2
257 SE   4 Second mounting point body ID, Second node ID
258 SE   4 Input axis unit vector (IA) x,y,z                          3 2 1
259 SE   4 Mounting point Hinge index, Axis index
260 SE   4 First focal plane unit vector  (Fp1) x,y,z
261 SE   4 Second focal plane unit vector (Fp2) x,y,z
262 SE   4 Sun/Star unit vector (Us) x,y,z
263 SE   4 Velocity Aberration Option (Y/N)
264 SE   4 Euler Angle Sequence (1-6)
265 SE   4 CMG ID number and Gimbal number
266 SE   4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE   5 Sensor ID number                                           5
268 SE   5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)         ST
269 SE   5 Mounting point body ID, Mounting point node ID             2 5
270 SE   5 Second mounting point body ID, Second node ID
271 SE   5 Input axis unit vector (IA) x,y,z
272 SE   5 Mounting point Hinge index, Axis index
273 SE   5 First focal plane unit vector  (Fp1) x,y,z                 0 0 1
274 SE   5 Second focal plane unit vector (Fp2) x,y,z                 0 -1 0
275 SE   5 Sun/Star unit vector (Us) x,y,z                            0 0 0
276 SE   5 Velocity Aberration Option (Y/N)                           N
277 SE   5 Euler Angle Sequence (1-6)
278 SE   5 CMG ID number and Gimbal number
279 SE   5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE   6 Sensor ID number                                           6
281 SE   6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV         A3
282 SE   6 Mounting point body ID, Mounting point node ID             2 2
283 SE   6 Second mounting point body ID, Second node ID
284 SE   6 Input axis unit vector (IA) x,y,z
285 SE   6 Mounting point Hinge index, Axis index
286 SE   6 First focal plane unit vector  (Fp1) x,y,z
287 SE   6 Second focal plane unit vector (Fp2) x,y,z
288 SE   6 Sun/Star unit vector (Us) x,y,z
289 SE   6 Velocity Aberration Option (Y/N)
290 SE   6 Euler Angle Sequence (1-6)
291 SE   6 CMG ID number and Gimbal number
292 SE   6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE   7 Sensor ID number                                           7
294 SE   7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV         AC
295 SE   7 Mounting point body ID, Mounting point node ID             2 2
296 SE   7 Second mounting point body ID, Second node ID
297 SE   7 Input axis unit vector (IA) x,y,z                          1 0 0
298 SE   7 Mounting point Hinge index, Axis index
299 SE   7 First focal plane unit vector  (Fp1) x,y,z
300 SE   7 Second focal plane unit vector (Fp2) x,y,z
301 SE   7 Sun/Star unit vector (Us) x,y,z
302 SE   7 Velocity Aberration Option (Y/N)
303 SE   7 Euler Angle Sequence (1-6)
304 SE   7 CMG ID number and Gimbal number
305 SE   7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

         ACTR

306 AC   1 Actuator ID number                                         1
307 AC   1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                        MO
308 AC   1 Actuator location; Node or Hinge (N or H)
309 AC   1 Mounting point body ID number, node ID number              2 2
310 AC   1 Second mounting point body ID, second node ID
311 AC   1 Output axis unit vector x,y,z                              0 1 0
312 AC   1 Mounting point Hinge index, Axis index
313 AC   1 Rotor spin axis unit vector x,y,z
```

```
314 AC   1 Initial rotor momentum, H
315 AC   1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
316 AC   1 Outer gimbal axis unit vector x,y,z
317 AC   1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
318 AC   1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
319 AC   1 Inner gimbal axis unit vector x,y,z
320 AC   1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
321 AC   1 Initial length and rate, y(to) and ydot(to)
322 AC   1 Constants; K1 or wo, n or zeta, Kg, Jm
323 AC   1 Non-linearities; TLim, Tco, Dz

324 AC   2 Actuator ID number                                 2
325 AC   2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
326 AC   2 Actuator location; Node or Hinge (N or H)
327 AC   2 Mounting point body ID number, node ID number      2 2
328 AC   2 Second mounting point body ID, second node ID
329 AC   2 Output axis unit vector x,y,z                      0 0 1
330 AC   2 Mounting point Hinge index, Axis index
331 AC   2 Rotor spin axis unit vector x,y,z
332 AC   2 Initial rotor momentum, H
333 AC   2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
334 AC   2 Outer gimbal axis unit vector x,y,z
335 AC   2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
336 AC   2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
337 AC   2 Inner gimbal axis unit vector x,y,z
338 AC   2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
339 AC   2 Initial length and rate, y(to) and ydot(to)
340 AC   2 Constants; K1 or wo, n or zeta, Kg, Jm
341 AC   2 Non-linearities; TLim, Tco, Dz

342 AC   3 Actuator ID number                                 3
343 AC   3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
344 AC   3 Actuator location; Node or Hinge (N or H)
345 AC   3 Mounting point body ID number, node ID number      2 2
346 AC   3 Second mounting point body ID, second node ID
347 AC   3 Output axis unit vector x,y,z                      1 0 0
348 AC   3 Mounting point Hinge index, Axis index
349 AC   3 Rotor spin axis unit vector x,y,z
350 AC   3 Initial rotor momentum, H
351 AC   3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
352 AC   3 Outer gimbal axis unit vector x,y,z
353 AC   3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
354 AC   3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
355 AC   3 Inner gimbal axis unit vector x,y,z
356 AC   3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
357 AC   3 Initial length and rate, y(to) and ydot(to)
358 AC   3 Constants; K1 or wo, n or zeta, Kg, Jm
359 AC   3 Non-linearities; TLim, Tco, Dz

360 AC   4 Actuator ID number                                 4
361 AC   4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
362 AC   4 Actuator location; Node or Hinge (N or H)
363 AC   4 Mounting point body ID number, node ID number      3 2
364 AC   4 Second mounting point body ID, second node ID
365 AC   4 Output axis unit vector x,y,z                      1 0 0
366 AC   4 Mounting point Hinge index, Axis index
367 AC   4 Rotor spin axis unit vector x,y,z
368 AC   4 Initial rotor momentum, H
369 AC   4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
370 AC   4 Outer gimbal axis unit vector x,y,z
371 AC   4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
372 AC   4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
373 AC   4 Inner gimbal axis unit vector x,y,z
374 AC   4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
375 AC   4 Initial length and rate, y(to) and ydot(to)
376 AC   4 Constants; K1 or wo, n or zeta, Kg, Jm
377 AC   4 Non-linearities; TLim, Tco, Dz

378 AC   5 Actuator ID number                                 5
379 AC   5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
380 AC   5 Actuator location; Node or Hinge (N or H)
```

```
381 AC   5 Mounting point body ID number, node ID number      3 2
382 AC   5 Second mounting point body ID, second node ID
383 AC   5 Output axis unit vector x,y,z                      0 1 0
384 AC   5 Mounting point Hinge index, Axis index
385 AC   5 Rotor spin axis unit vector x,y,z
386 AC   5 Initial rotor momentum, H
387 AC   5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
388 AC   5 Outer gimbal axis unit vector x,y,z
389 AC   5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
390 AC   5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
391 AC   5 Inner gimbal axis unit vector x,y,z
392 AC   5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
393 AC   5 Initial length and rate, y(to) and ydot(to)
394 AC   5 Constants; K1 or wo, n or zeta, Kg, Jm
395 AC   5 Non-linearities; TLim, Tco, Dz

396 AC   6 Actuator ID number                                 6
397 AC   6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
398 AC   6 Actuator location; Node or Hinge (N or H)
399 AC   6 Mounting point body ID number, node ID number      3 2
400 AC   6 Second mounting point body ID, second node ID
401 AC   6 Output axis unit vector x,y,z                      0 0 1
402 AC   6 Mounting point Hinge index, Axis index
403 AC   6 Rotor spin axis unit vector x,y,z
404 AC   6 Initial rotor momentum, H
405 AC   6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
406 AC   6 Outer gimbal axis unit vector x,y,z
407 AC   6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
408 AC   6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
409 AC   6 Inner gimbal axis unit vector x,y,z
410 AC   6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
411 AC   6 Initial length and rate, y(to) and ydot(to)
412 AC   6 Constants; K1 or wo, n or zeta, Kg, Jm
413 AC   6 Non-linearities; TLim, Tco, Dz

414 AC   7 Actuator ID number                                 7
415 AC   7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
416 AC   7 Actuator location; Node or Hinge (N or H)
417 AC   7 Mounting point body ID number, node ID number      4 2
418 AC   7 Second mounting point body ID, second node ID
419 AC   7 Output axis unit vector x,y,z                      1 0 0
420 AC   7 Mounting point Hinge index, Axis index
421 AC   7 Rotor spin axis unit vector x,y,z
422 AC   7 Initial rotor momentum, H
423 AC   7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
424 AC   7 Outer gimbal axis unit vector x,y,z
425 AC   7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
426 AC   7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
427 AC   7 Inner gimbal axis unit vector x,y,z
428 AC   7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
429 AC   7 Initial length and rate, y(to) and ydot(to)
430 AC   7 Constants; K1 or wo, n or zeta, Kg, Jm
431 AC   7 Non-linearities; TLim, Tco, Dz

432 AC   8 Actuator ID number                                 8
433 AC   8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                MO
434 AC   8 Actuator location; Node or Hinge (N or H)
435 AC   8 Mounting point body ID number, node ID number      4 2
436 AC   8 Second mounting point body ID, second node ID
437 AC   8 Output axis unit vector x,y,z                      0 1 0
438 AC   8 Mounting point Hinge index, Axis index
439 AC   8 Rotor spin axis unit vector x,y,z
440 AC   8 Initial rotor momentum, H
441 AC   8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
442 AC   8 Outer gimbal axis unit vector x,y,z
443 AC   8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
444 AC   8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
445 AC   8 Inner gimbal axis unit vector x,y,z
446 AC   8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
447 AC   8 Initial length and rate, y(to) and ydot(to)
448 AC   8 Constants; K1 or wo, n or zeta, Kg, Jm
```

```
449 AC    8 Non-linearities; TLim, Tco, Dz

450 AC    9 Actuator ID number                                    9
451 AC    9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)                MO
452 AC    9 Actuator location; Node or Hinge (N or H)
453 AC    9 Mounting point body ID number, node ID number         4 2
454 AC    9 Second mounting point body ID, second node ID
455 AC    9 Output axis unit vector x,y,z                         0 0 1
456 AC    9 Mounting point Hinge index, Axis index
457 AC    9 Rotor spin axis unit vector x,y,z
458 AC    9 Initial rotor momentum, H
459 AC    9 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
460 AC    9 Outer gimbal axis unit vector x,y,z
461 AC    9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
462 AC    9 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
463 AC    9 Inner gimbal axis unit vector x,y,z
464 AC    9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
465 AC    9 Initial length and rate, y(to) and ydot(to)
466 AC    9 Constants; K1 or wo, n or zeta, Kg, Jm
467 AC    9 Non-linearities; TLim, Tco, Dz

468 AC   10 Actuator ID number                                    10
469 AC   10 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)                J
470 AC   10 Actuator location; Node or Hinge (N or H)
471 AC   10 Mounting point body ID number, node ID number         2 5
472 AC   10 Second mounting point body ID, second node ID
473 AC   10 Output axis unit vector x,y,z                         -1 0 0
474 AC   10 Mounting point Hinge index, Axis index
475 AC   10 Rotor spin axis unit vector x,y,z
476 AC   10 Initial rotor momentum, H
477 AC   10 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
478 AC   10 Outer gimbal axis unit vector x,y,z
479 AC   10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
480 AC   10 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
481 AC   10 Inner gimbal axis unit vector x,y,z
482 AC   10 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
483 AC   10 Initial length and rate, y(to) and ydot(to)
484 AC   10 Constants; K1 or wo, n or zeta, Kg, Jm
485 AC   10 Non-linearities; TLim, Tco, Dz

            CONTROLLER

486 CO    1 Controller ID number                                  1
487 CO    1 Controller type (CB,CM,DB,DM,UC,UD)                   CM
488 CO    1 Sample time (sec)
489 CO    1 Number of inputs, Number of outputs                   9 9
490 CO    1 Number of states
491 CO    1 Output No., Input type (I,S,T), Input ID, Gain

            INTERCONNECT

492 IN    1 Interconnect ID number                                1
493 IN    1 Source type(S,C, or F),Source ID,Source row #         S 1 1
494 IN    1 Destination type(A or C),Dest ID,Dest row #           C 1 1
495 IN    1 Gain                                                  4.41E13

496 IN    2 Interconnect ID number                                2
497 IN    2 Source type(S,C, or F),Source ID,Source row #         C 1 1
498 IN    2 Destination type(A or C),Dest ID,Dest row #           A 1 1
499 IN    2 Gain                                                  1

500 IN    3 Interconnect ID number                                3
501 IN    3 Source type(S,C, or F),Source ID,Source row #         S 1 2
502 IN    3 Destination type(A or C),Dest ID,Dest row #           C 1 2
503 IN    3 Gain                                                  1.67E12

504 IN    4 Interconnect ID number                                4
505 IN    4 Source type(S,C, or F),Source ID,Source row #         C 1 2
506 IN    4 Destination type(A or C),Dest ID,Dest row #           A 2 1
```

```
507 IN    4 Gain                                                    1

508 IN    5 Interconnect ID number                                  5
509 IN    5 Source type(S,C, or F),Source ID,Source row #           S 2 1
510 IN    5 Destination type(A or C),Dest ID,Dest row #             C 1 3
511 IN    5 Gain                                                    4.31E13

512 IN    6 Interconnect ID number                                  6
513 IN    6 Source type(S,C, or F),Source ID,Source row #           C 1 3
514 IN    6 Destination type(A or C),Dest ID,Dest row #             A 3 1
515 IN    6 Gain                                                    1

516 IN    7 Interconnect ID number                                  7
517 IN    7 Source type(S,C, or F),Source ID,Source row #           S 3 1
518 IN    7 Destination type(A or C),Dest ID,Dest row #             C 1 4
519 IN    7 Gain                                                    1.7E12

520 IN    8 Interconnect ID number                                  8
521 IN    8 Source type(S,C, or F),Source ID,Source row #           C 1 4
522 IN    8 Destination type(A or C),Dest ID,Dest row #             A 4 1
523 IN    8 Gain                                                    1

524 IN    9 Interconnect ID number                                  9
525 IN    9 Source type(S,C, or F),Source ID,Source row #           S 3 2
526 IN    9 Destination type(A or C),Dest ID,Dest row #             C 1 5
527 IN    9 Gain                                                    1.7E12

528 IN   10 Interconnect ID number                                  10
529 IN   10 Source type(S,C, or F),Source ID,Source row #           C 1 5
530 IN   10 Destination type(A or C),Dest ID,Dest row #             A 5 1
531 IN   10 Gain                                                    1

532 IN   11 Interconnect ID number                                  11
533 IN   11 Source type(S,C, or F),Source ID,Source row #           S 3 3
534 IN   11 Destination type(A or C),Dest ID,Dest row #             C 1 6
535 IN   11 Gain                                                    3.4E12

536 IN   12 Interconnect ID number                                  12
537 IN   12 Source type(S,C, or F),Source ID,Source row #           C 1 6
538 IN   12 Destination type(A or C),Dest ID,Dest row #             A 6 1
539 IN   12 Gain                                                    1

540 IN   13 Interconnect ID number                                  13
541 IN   13 Source type(S,C, or F),Source ID,Source row #           S 4 1
542 IN   13 Destination type(A or C),Dest ID,Dest row #             C 1 7
543 IN   13 Gain                                                    1.7E12

544 IN   14 Interconnect ID number                                  14
545 IN   14 Source type(S,C, or F),Source ID,Source row #           C 1 7
546 IN   14 Destination type(A or C),Dest ID,Dest row #             A 7 1
547 IN   14 Gain                                                    1

548 IN   15 Interconnect ID number                                  15
549 IN   15 Source type(S,C, or F),Source ID,Source row #           S 4 2
550 IN   15 Destination type(A or C),Dest ID,Dest row #             C 1 8
551 IN   15 Gain                                                    1.7E12

552 IN   16 Interconnect ID number                                  16
553 IN   16 Source type(S,C, or F),Source ID,Source row #           C 1 8
554 IN   16 Destination type(A or C),Dest ID,Dest row #             A 8 1
555 IN   16 Gain                                                    1

556 IN   17 Interconnect ID number                                  17
557 IN   17 Source type(S,C, or F),Source ID,Source row #           S 4 3
558 IN   17 Destination type(A or C),Dest ID,Dest row #             C 1 9
559 IN   17 Gain                                                    3.4E12

560 IN   18 Interconnect ID number                                  18
561 IN   18 Source type(S,C, or F),Source ID,Source row #           C 1 9
562 IN   18 Destination type(A or C),Dest ID,Dest row #             A 9 1
563 IN   18 Gain                                                    1
```

```
564 IN  19 Interconnect ID number                                   19
565 IN  19 Source type(S,C, or F),Source ID,Source row #            S 5 3
566 IN  19 Destination type(A or C),Dest ID,Dest row #              A 10 1
567 IN  19 Gain                                                     7
```

isc3_flex_sol.lin (Concept 3) Summer Solstice

```
* Controller for integrated symmetrical concentrator
system CONT1 18,9,9,0,0,0.0
*A
0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
-1 -1.4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 -1 -1.4 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 -1 -1.4 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 -1 -1.4 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 -1 -1.4 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 -1 -1.4 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 -1 -1.4 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 -1 -1.4 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 -1 -1.4
*B
0 0 0 0 0 0 0 0 0
1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 1 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 1 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 1
*C
.000025 .007  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 .000025 .007 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 .000025 .007 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 .0001 .014  0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 .0001 .014  0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 .0001 .014 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 .0001 .014  0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 .0001 .014
*D
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0
*H
*M
```

los.dat (Concept 3) Summer Solstice

```
3,                 ! Sensor number of 1st FGS (clamshell) sensor
0.d0,0.d0,0.d0,        ! Defaults to sun as a target for zero input vector
0.d0, -1.d0,0.d0,      ! Target star along negative polar axis
0.d0,-1.d0,0.d0,       ! Focal plane vector 1
1.d0,0.d0,0.d0,        ! Focal plane vector 2
1.d0,0.d0,0.d0,        ! Focal plane vector 3

 4,                ! Sensor number of 2nd FGS (clamshell) sensor
0.d0,0.d0,0.d0,        ! Defaults to sun as a target for zero input vector
0.d0, 1.d0,0.d0,       ! Target star along positive polar axis
0.d0,-1.d0,0.d0,       ! Focal plane vector 1
1.d0,0.d0,0.d0,        ! Focal plane vector 2
-1.d0,0.d0,0.d0,       ! Focal plane vector 3
```

solar_pressure.dat (Concept 3) Summer Solstice

```
22, 'm',       ! number of panels, units English or Metric ***Updated 11/15/00***
1,2,638000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
1,2,638000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,-7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,-7.972d2,  ! body, node, area, reflectivity factor,outward normal,centroid
1,3,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,-7.972d2,  ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,1.d0,0.d0,0.d0,0.d0,7.972d2,    ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,-1.d0,0.d0,0.d0,0.d0,0.d0,7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
1,4,319000.d0,0.5d0,0.d0,-1.d0,0.d0,0.d0,0.d0,7.972d2,   ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0,  0.1736d0,0.d0,0.9848d0,0.d0,0.d0,0.d0,   ! body, node, area, reflectivity factor,outward normal,centroid
2,3,785000.d0,0.0d0,  -0.1736d0,1.d0,-0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0,  0.1736d0,0.d0,-0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,4,785000.d0,0.0d0,  -0.1736d0,-1.d0,0.9848d0,0.d0,0.d0,0.d0,  ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0, 1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
2,5,196000.d0,0.0d0,-1.d0,0.d0,0.d0,0.d0,0.d0,0.d0,    ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,        ! body, node, area, reflectivity factor,outward normal,centroid
3,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,       ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,1.d0,0.d0,0.d0,0.d0,        ! body, node, area, reflectivity factor,outward normal,centroid
4,2,1.04d7,1.0d0,0.d0,0.d0,-1.d0,0.d0,0.d0,0.d0,       ! body, node, area, reflectivity factor,outward normal,centroid
```

isc3_flex_sol.flx (Concept 3) Summer Solstice (An excerpt)

```
flag, revision number
XXXXXX          1
  body id
        1
  modes, nodes, modal options
      24         4         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
       0         0         0         0         0         0         0         0
  phi_t for node #              2
  .31310941E-02 -.16357954E-03  .19158607E-08  .68659216E-04  .31346273E-02
  .14949358E-08 -.33409338E-09 -.17910070E-08 -.62130721E-04  .10048928E-08
  .74260327E-10 -.81693812E-09  .66744219E-10 -.57300403E-09  .56292416E-10
 -.31109642E-09  .51999889E-08  .41569313E-10  .36697769E-02  .69502051E-03
  .85567197E-10 -.10557893E-02  .35826871E-02  .65924560E-10  .61553749E-10
  .11085623E-08 -.67301328E-05  .49549244E-10 -.49437998E-08 -.60865848E-11
  .10484816E-08  .39239830E-10 -.17858973E-09  .46440350E-10  .23145265E-09
  .76239104E-11 -.98486197E-09 -.52382674E-09  .30708566E-12  .12143532E-10
 -.10722701E-09  .94529479E-03  .17735129E-08  .15323995E-09  .13868812E-12
 -.13390485E-02 -.55272105E-04 -.82202021E-12  .55317399E-04 -.13390483E-02
  .27552836E-11  .29149021E-10 -.27567962E-12 -.44865972E-10  .48584658E-11
  .10595799E-10 -.31919479E-08 -.19937738E-10  .14255509E-09 -.23770452E-02
 -.45933446E-03 -.19673179E-04  .63985161E-12 -.19675549E-04  .45933391E-03
 -.74265281E-12 -.34874105E-11 -.12587102E-11  .59687765E-09 -.12099360E-11
 -.69004494E-11  .19524343E-08
  phi_t prime for node #              2
  .17177767E-11 -.22808543E-11 -.45683561E-10  .19817016E-10  .56718933E-12
  .31514104E-09  .17463000E-11 -.27057756E-13 -.60467460E-12  .11400599E-06
 -.42543750E-05 -.11919737E-10  .42546793E-05  .10153760E-06 -.34352434E-10
  .41859459E-11 -.37080794E-11  .59234151E-04  .45504345E-11 -.70844966E-12
  .15588470E-10  .13593377E-10  .68741697E-12  .87795145E-10 -.28497036E-11
  .31909564E-13 -.69421743E-15  .38765922E-11 -.41335440E-11 -.44983453E-04
  .22473012E-05 -.13022411E-04  .41075666E-11 -.13101519E-04 -.17274113E-05
 -.98017672E-11 -.14778531E-12 -.42275125E-13 -.96071643E-06 -.25440820E-11
  .54200130E-11  .41425181E-12 -.51084189E-13  .98880082E-15  .14899414E-06
 -.49351318E-14  .15066380E-14 -.42969795E-10 -.54223125E-14  .27635772E-15
 -.79851673E-11  .23444071E-06 -.40722409E-05 -.13017710E-13  .40722809E-05
  .23382333E-06  .64327760E-12 -.80030821E-11  .19070818E-11  .27557384E-13
  .67193209E-14  .15459451E-13  .15489036E-10  .28188639E-13  .15021236E-15
  .22611633E-11 -.61243211E-07  .17482812E-05  .30019490E-13 -.17482739E-05
 -.61449314E-07 -.27684414E-12
  phi_t for node #              3
 -.42404714E-02  .49480955E-03  .19835813E-08 -.36612814E-03 -.42534660E-02
  .96750031E-09  .42209027E-09  .30963712E-08  .40516924E-04  .38549281E-02
 -.52714285E-03 -.87737477E-09  .53843743E-03  .38533672E-02 -.10363838E-09
  .38623427E-08 -.71743451E-08  .24131659E-03  .31427071E-02 -.10270931E-03
  .15812594E-09 -.20969267E-03  .31373775E-02  .44642715E-09  .28790083E-09
  .88009461E-09  .18408168E-03 -.17813513E-08 -.27431844E-08  .15957166E-04
 -.19242852E-02  .34087019E-03 -.22330623E-09  .41716037E-03  .19091971E-02
 -.71605887E-10  .95016675E-09 -.81490514E-09  .32861442E-02 -.18116747E-08
  .55541036E-09  .79551900E-03 -.41608643E-08 -.26069981E-09  .94036451E-02
  .21682867E-02 -.12127210E-02  .85710915E-08  .12126479E-02  .21683282E-02
 -.39141685E-08  .18971552E-02 -.12009168E-02  .43705940E-08  .12012029E-02
  .18969745E-02  .16937062E-07 -.67726532E-08 -.66549206E-08  .11440634E-01
  .49982895E-02 -.24804966E-02  .39527267E-09 -.24804686E-02 -.49983050E-02
 -.34622476E-08 -.50056020E-02  .25440974E-02 -.23331468E-08 -.25435047E-02
 -.50059046E-02 -.85708461E-08
  phi_t prime for node #              3
 -.50525028E-06 -.31564387E-05 -.80521842E-10  .31702786E-05 -.40940183E-06
  .57389171E-09 -.26678138E-11  .65900274E-12 -.58046889E-04  .10244708E-05
  .47674564E-05  .15531760E-10 -.47644389E-05  .10384376E-05  .44257276E-10
  .11200572E-10  .49389619E-11 -.61429724E-04  .68382965E-06  .54576833E-05
 -.20073106E-10 -.54985919E-05  .13880871E-06 -.11950858E-09 -.12906028E-11
  .35486701E-12 -.77274292E-04  .61171041E-11 -.56114520E-11 -.65377923E-04
 -.17172111E-05 -.54788611E-05  .24079039E-11 -.54062017E-05  .19338345E-05
  .41797610E-11  .67570000E-11  .20000043E-10  .51675836E-06 -.99163146E-11
 -.24536147E-10  .16113741E-05 -.24387637E-10 -.45291231E-10  .14474359E-04
  .40550997E-04  .55846277E-04 -.22605263E-10 -.55847708E-04  .40549096E-04
```

```
-.12064872E-11  .40806300E-04  .51925447E-04 -.22326921E-10 -.51919351E-04
 .40814113E-04  .35521932E-10  .15828591E-09 -.16771401E-09  .21209458E-04
 .16987298E-03  .27619447E-03  .11975439E-09  .27619558E-03 -.16987148E-03
-.57982074E-10 -.17376694E-03 -.27781790E-03 -.11765510E-09  .27783862E-03
-.17373409E-03 -.70075300E-10
 phi_t for node #          4
-.42404802E-02  .49480360E-03  .18585028E-08 -.36612933E-03 -.42535396E-02
 .21036956E-08  .39723035E-09 -.14786269E-09  .40516905E-04 -.38549306E-02
 .52714303E-03 -.77214743E-09 -.53843745E-03 -.38533660E-02  .20798890E-09
-.73886299E-08 -.15978809E-07 -.24131650E-03  .31427093E-02 -.10270436E-03
 .13801450E-10 -.20968938E-03  .31373931E-02 -.39914612E-09  .41931685E-11
 .99616139E-10  .18408168E-03  .35438059E-09 -.17390277E-08 -.15957178E-04
 .19242857E-02 -.34087031E-03 -.23866856E-09 -.41716036E-03 -.19091972E-02
-.19395891E-10  .94356214E-09 -.84924469E-09 -.32861442E-02  .18078300E-08
-.56604075E-09  .79551900E-03 -.41738415E-08 -.28114281E-09 -.94036451E-02
 .21682868E-02 -.12127209E-02 -.85410786E-08  .12126480E-02  .21683284E-02
 .38256346E-08 -.18971552E-02  .12009169E-02  .43704936E-08 -.12012030E-02
-.18969746E-02  .17005110E-07  .67789071E-08  .66775796E-08  .11440634E-01
 .49982897E-02 -.24804968E-02 -.39492666E-09 -.24804688E-02 -.49983053E-02
 .34827434E-08  .50056020E-02 -.25440973E-02 -.23324836E-08  .25435049E-02
 .50059050E-02 -.85841247E-08
 phi_t prime for node #          4
 .50524725E-06  .31564441E-05 -.82070494E-10 -.31703213E-05  .40940604E-06
 .62154334E-09  .34011412E-12 -.27858908E-12  .58046878E-04  .10244712E-05
 .47674599E-05  .13355611E-10 -.47644372E-05  .10384375E-05  .44054122E-10
-.22077045E-10  .11247290E-10 -.61429722E-04 -.68382100E-06 -.54576879E-05
-.24245181E-10  .54986198E-05 -.13881681E-06 -.15347238E-09  .50958361E-12
-.41824742E-12  .77274292E-04 -.42833617E-11  .34928804E-12 -.65377921E-04
-.17172117E-05 -.54788625E-05  .15891701E-11 -.54062019E-05  .19338345E-05
-.90655410E-11 -.71395520E-11 -.19852937E-10  .51675837E-06 -.10061491E-10
-.24464605E-10 -.16113739E-05  .23986931E-10  .45635598E-10  .14474359E-04
-.40550995E-04 -.55846279E-04 -.22604313E-10  .55847713E-04 -.40549100E-04
-.14851140E-11  .40806300E-04  .51925447E-04  .22357522E-10 -.51919354E-04
 .40814116E-04 -.35835384E-10  .15906312E-09 -.16795738E-09 -.21209458E-04
-.16987299E-03 -.27619447E-03  .11979215E-09 -.27619560E-03  .16987149E-03
-.57726900E-10 -.17376694E-03 -.27781789E-03  .11764036E-09  .27783864E-03
-.17373411E-03  .70185849E-10
 mass matrix
 .10000000E+01 -.30291562E-01 -.76876291E-07  .73800796E-06  .32867117E-06
 .13158549E-06 -.92633251E-08 -.17952422E-07  .62673968E-08 -.19995321E-07
 .20953681E-06 -.61379992E-07  .12006683E-09 -.11753664E-09  .88805322E-10
 .18582751E-09  .93589593E-10  .34601899E-08  .12520782E-08  .51220876E-10
-.26895388E-10 -.46932083E-10 -.51456416E-09 -.16699282E-09 -.30291562E-01
 .10000000E+01  .26989693E-07  .24701420E-07  .34123181E-05  .19569915E-07
 .18126030E-07 -.22083024E-07 -.30895835E-08 -.63797417E-09  .13846796E-06
-.91584230E-06  .28463240E-09 -.92291186E-09  .13196997E-09 -.83498605E-10
-.23061102E-09  .37066771E-09  .14015707E-07  .71524564E-09 -.97352491E-12
-.79781628E-10 -.28504651E-10 -.24628018E-08 -.76876291E-07  .26989693E-07
 .10000000E+01 -.12820039E-07  .23873133E-06  .46502856E-07  .48615925E-08
-.31587180E-08 -.94997621E-10 -.56075172E-08  .49113872E-08 -.51914907E-07
-.57636964E-11  .45511296E-10  .45041193E-11 -.28608624E-10  .92163317E-11
-.16290986E-10  .76859350E-09 -.31071312E-10 -.47158520E-11 -.13956592E-11
 .40931813E-11 -.13308932E-09  .73800796E-06  .24701420E-07 -.12820039E-07
 .10000000E+01  .29302137E-02  .10572523E-05 -.24430484E-06  .68476034E-07
 .92720426E-09 -.64534578E-07  .16242822E-07  .86600013E-08  .72440444E-09
 .16245107E-08 -.11209088E-09  .55930229E-10 -.44166054E-09 -.10256621E-08
-.50144862E-09 -.15880740E-08  .25789654E-09 -.98514653E-10 -.37720327E-09
 .27460623E-09  .32867117E-06  .34123181E-05  .23873133E-06  .29302137E-02
 .10000000E+01  .71189247E-06 -.53815780E-06 -.15566832E-05  .83251907E-07
-.45009419E-07 -.44807150E-07  .17705875E-07 -.16602525E-08 -.43070508E-08
-.20692528E-09  .20019442E-08  .57241159E-08 -.72556163E-09  .93151063E-09
 .18206492E-08 -.13561118E-09 -.12897281E-08 -.25829052E-10  .16156569E-09
 .13158549E-06  .19569915E-07  .46502856E-07  .10572523E-05  .71189247E-06
 .10000000E+01 -.83160269E-07  .24349543E-07  .11233865E-07  .10028917E-06
-.12313102E-06  .70134651E-07 -.13207290E-08  .28173844E-08 -.11660397E-08
 .22882173E-09 -.30171128E-09 -.14728997E-08 -.13109908E-08  .32317686E-09
 .12105915E-10 -.55168990E-10  .27914248E-09  .14656790E-09 -.92633250E-08
 .18126030E-07  .48615925E-08 -.24430484E-06 -.53815780E-06 -.83160269E-07
 .10000000E+01 -.99242756E-01  .22394316E-07 -.39958298E-07  .32234509E-06
-.50160922E-06  .23636843E-09 -.21910738E-09  .14348669E-09  .15847338E-09
 .74774558E-10  .32733302E-08  .57239272E-08  .10031900E-09 -.36640911E-10
```

-.81560611E-10	-.45187655E-09	-.93057423E-09	-.17952422E-07	-.22083024E-07
-.31587180E-08	.68476034E-07	-.15566832E-05	.24349543E-07	-.99242756E-01
.10000000E+01	-.20074054E-07	.16458235E-07	.15485050E-06	-.15630944E-05
.29386609E-09	-.10163269E-08	.11846928E-09	-.20501990E-09	-.41770205E-09
-.56246450E-09	.16797163E-07	.78252621E-09	.33675344E-11	-.57812240E-10
.11108613E-09	-.29422473E-08	.62673968E-08	-.30895835E-08	-.94997760E-10
.92720426E-09	.83251907E-07	.11233865E-07	.22394316E-07	-.20074054E-07
.10000000E+01	.12712850E-07	-.23627686E-07	.15204590E-06	.96068819E-11
-.66710239E-10	-.23527708E-12	.57865057E-10	-.34048646E-10	-.56274547E-10
-.13467924E-08	.57321148E-10	.72512622E-11	.43261077E-11	.42475879E-11
.23009307E-09	-.19995321E-07	-.63797417E-09	-.56075174E-08	-.64534578E-07
-.45009419E-07	.10028917E-06	-.39958298E-07	.16458235E-07	.12712850E-07
.10000000E+01	.34013758E-06	-.19456390E-06	.12276100E-08	-.23143374E-08
.90995226E-09	-.20703316E-09	.26711414E-09	.17484259E-08	.14384415E-08
-.22089987E-09	-.12869248E-10	.38339013E-10	-.31448481E-09	-.18544250E-09
.20953681E-06	.13846796E-06	.49113872E-08	.16242822E-07	-.44807150E-07
-.12313102E-06	.32234509E-06	.15485050E-06	-.23627686E-07	.34013758E-06
.10000000E+01	-.39786267E-01	.17049808E-08	.38885439E-08	-.46588188E-09
.12616452E-08	.13318808E-08	-.42894021E-08	.74108288E-09	-.45855306E-08
.76304756E-09	-.90324773E-09	-.10747486E-08	.61285555E-09	-.61379992E-07
-.91584230E-06	-.51914907E-07	.86600013E-08	.17705875E-07	.70134651E-07
-.50160922E-06	-.15630944E-05	.15204590E-06	-.19456390E-06	-.39786267E-01
.10000000E+01	.62505978E-08	.15167020E-07	.64225500E-09	-.64493380E-08
-.19359751E-07	.14627884E-08	-.39742767E-08	-.61200326E-08	.51696455E-09
.41021165E-08	.38755886E-10	-.28087086E-09	.12006683E-09	.28463240E-09
-.57637523E-11	.72440444E-09	-.16602525E-08	-.13207290E-08	.23636843E-09
.29386609E-09	.96069199E-11	.12276100E-08	.17049808E-08	.62505978E-08
.10000000E+01	.73552646E-10	.38814802E-10	.36872491E-10	.72462767E-10
-.30908303E-09	.78347194E-09	-.80736378E-10	.38873326E-11	-.52248843E-11
.43195040E-10	-.10247581E-09	-.11753664E-09	-.92291186E-09	.45511310E-10
.16245107E-08	-.43070508E-08	.28173844E-08	-.21910738E-09	-.10163269E-08
-.66710219E-10	-.23143374E-08	.38885439E-08	.15167020E-07	.73552316E-10
.10000000E+01	-.15617476E-09	-.61749360E-11	-.26777146E-09	-.10599770E-08
.29161646E-08	-.20094998E-09	.18211917E-10	.26472063E-10	.16702574E-09
-.34247066E-09	.88805322E-10	.13196997E-09	.45041462E-11	-.11209088E-09
-.20692528E-09	-.11660397E-08	.14348669E-09	.11846928E-09	-.23525973E-12
.90995225E-09	-.46588188E-09	.64225500E-09	.38814889E-10	-.15617482E-09
.10000000E+01	.12187317E-09	.15001747E-09	.24640744E-09	.42025294E-09
-.18289440E-09	.56313574E-11	-.72942198E-11	-.17559408E-10	-.32344202E-10
.18582743E-09	-.83498576E-10	-.28608624E-10	.55930264E-10	.20019442E-08
.22882173E-09	.15847327E-09	-.20501985E-09	.57865057E-10	-.20703316E-09
.12616453E-08	-.64493380E-08	.36872491E-10	-.61749360E-11	.12187317E-09
.10000000E+01	-.32661816E-04	-.43944057E-08	-.24952357E-07	.81538381E-10
.34212335E-10	.38356819E-10	.24612814E-10	.46331501E-09	.93589566E-10
-.23061114E-09	.92163317E-11	-.44166048E-09	.57241158E-08	-.30171128E-09
.74774490E-10	-.41770205E-09	-.34048646E-10	.26711414E-09	.13318808E-08
-.19359751E-07	.72462767E-10	-.26777146E-09	.15001747E-09	-.32661816E-04
.10000000E+01	.42300905E-08	-.73197671E-07	-.10441846E-08	-.14602376E-11
.73313057E-10	-.10191802E-09	.14986050E-08	.34601900E-08	.37066776E-09
-.16290986E-10	-.10256622E-08	-.72556165E-09	-.14728997E-08	.32733303E-08
-.56246452E-09	-.56274547E-10	.17484259E-08	-.42894022E-08	.14627883E-08
-.30908303E-09	-.10599770E-08	.24640744E-09	-.43944057E-08	.42300905E-08
.10000000E+01	.15221368E-03	-.86338705E-08	.45921228E-09	-.20521056E-09
-.89116174E-09	.26024348E-09	.12520782E-08	.14015707E-07	.76859350E-09
-.50144861E-09	.93151061E-09	-.13109908E-08	.57239273E-08	.16797163E-07
-.13467924E-08	.14384415E-08	.74108288E-09	-.39742767E-08	.78347194E-09
.29161646E-08	.42025294E-09	-.24952357E-07	-.73197671E-07	.15221368E-03
.10000000E+01	.96863908E-08	-.22080642E-09	-.21316144E-08	-.16738301E-09
.50310155E-09	.51220876E-10	.71524564E-09	-.31071253E-10	-.15880740E-08
.18206492E-08	.32317686E-09	.10031900E-09	.78252621E-09	.57321209E-10
-.22089988E-09	-.45855306E-08	-.61200326E-08	-.80736291E-10	-.20094994E-09
-.18289443E-09	.81538381E-10	-.10441846E-08	-.86338705E-08	.96863908E-08
.10000000E+01	-.83286638E-10	-.96200651E-10	-.75748973E-09	.64933845E-09
-.26895791E-10	-.97338757E-12	-.47158520E-11	.25789669E-09	-.13561120E-09
.12105915E-10	-.36641097E-10	.33675814E-11	.72512622E-11	-.12869248E-10
.76304768E-09	.51696454E-09	.38873326E-11	.18211917E-10	.56313574E-11
.34212015E-10	-.14603011E-11	.45921242E-09	-.22080646E-09	-.83286638E-10
.10000000E+01	.58959486E-05	.14665321E-07	-.85539216E-08	-.46932053E-10
-.79781317E-10	-.13956592E-11	-.98514661E-10	-.12897281E-08	-.55168990E-10
-.81560497E-10	-.57812195E-10	.43261077E-11	.38339013E-10	-.90324783E-09
.41021164E-08	-.52248843E-11	.26472063E-10	-.72942198E-11	.38356856E-10

.73313071E-10	-.20521064E-09	-.21316143E-08	-.96200651E-10	.58959486E-05
.10000000E+01	-.59777300E-08	-.75550117E-07	-.51456404E-09	-.28504694E-10
.40931813E-11	-.37720340E-09	-.25829159E-10	.27914248E-09	-.45187665E-09
.11108611E-09	.42475879E-11	-.31448481E-09	-.10747487E-08	.38755748E-10
.43195040E-10	.16702574E-09	-.17559408E-10	.24612970E-10	-.10191791E-09
-.89116176E-09	-.16738308E-09	-.75748973E-09	.14665321E-07	-.59777301E-08
.10000000E+01	-.11866292E-03	-.16699269E-09	-.24628016E-08	-.13308932E-09
.27460630E-09	.16156571E-09	.14656790E-09	-.93057434E-09	-.29422474E-08
.23009307E-09	-.18544250E-09	.61285545E-09	-.28087069E-09	-.10247581E-09
-.34247066E-09	-.32344202E-10	.46331502E-09	.14986050E-08	.26024357E-09
.50310165E-09	.64933845E-09	-.85539216E-08	-.75550117E-07	-.11866292E-03
.10000000E+01				

damping matrix

.39515996E-02	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.39516161E-02	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.57051589E-02	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.10312256E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.10312269E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.11723114E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.18482064E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.18482067E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.21730454E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.26395027E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.33015249E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.33015287E-01	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00
.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00	.00000000E+00

```
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .85110374E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .96499772E-01  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .12323587E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14322839E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14322847E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14874285E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .14874293E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .16365219E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23335965E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23335978E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23420770E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .23420782E+00
stiffness matrix
 .97594620E-02 -.29562935E-03 -.75027124E-09  .72025612E-08  .32076552E-08
 .12842036E-08 -.90451014E-10 -.17520828E-09  .61166345E-10 -.19514395E-09
 .20449663E-08 -.59903455E-09  .11734955E-11 -.11566431E-11  .82897331E-12
 .18224390E-11  .91230355E-12  .33761495E-10  .12195177E-10  .39046523E-12
-.23182122E-12 -.45045983E-12 -.50303460E-11 -.16273291E-11 -.29563182E-03
 .97595435E-02  .26340700E-09  .24106267E-09  .33302668E-07  .19099210E-09
 .17684183E-09 -.21551112E-09 -.30152319E-10 -.62306491E-11  .13513914E-08
-.89381996E-08  .28259460E-11 -.90398944E-11  .13342475E-11 -.81528791E-12
-.22587225E-11  .35773535E-11  .13680596E-09  .72885717E-11  .13210152E-12
-.79094623E-12 -.24557427E-12 -.23989233E-10 -.15639020E-08  .54905123E-09
 .20343024E-01 -.26079975E-09  .48565154E-08  .94600863E-09  .98901407E-10
-.64254611E-10 -.19314411E-11 -.11407272E-09  .99913434E-10 -.10561077E-08
```

-.12958944E-12	.94279651E-12	.10015730E-12	-.57997122E-12	.18743726E-12
-.33130988E-12	.15637630E-10	-.59105368E-12	-.93439414E-13	-.27921324E-13
.81773561E-13	-.27093940E-11	.49050780E-07	.16417779E-08	-.85207293E-09
.66464133E-01	.19475411E-03	.70269359E-07	-.16237297E-07	.45511788E-08
.61626102E-10	-.42892336E-08	.10795968E-08	.57553439E-09	.48250404E-10
.10784259E-09	-.75078960E-11	.38099994E-11	-.29288332E-10	-.68250243E-10
-.33409452E-10	-.10524932E-09	.17471826E-10	-.66418785E-11	-.25134243E-10
.18277811E-10	.21845110E-07	.22679724E-06	.15867112E-07	.19475462E-03
.66464305E-01	.47315439E-07	-.35768462E-07	-.10346396E-06	.55332801E-08
-.29915172E-08	-.29780635E-08	.11768222E-08	-.11051827E-09	-.28583534E-09
-.13254065E-10	.13294086E-09	.38057802E-09	-.48296946E-10	.62028220E-10
.12099541E-09	-.92194702E-11	-.85621868E-10	-.16899667E-11	.10770092E-10
.11302504E-07	.16809534E-08	.39943453E-08	.90812287E-07	.61147734E-07
.85894623E-01	-.71430461E-08	.20915017E-08	.96492788E-09	.86143002E-08
-.10576290E-07	.60241884E-08	-.11344353E-09	.24197689E-09	-.10012414E-09
.19655470E-10	-.25911887E-10	-.12651469E-09	-.11260067E-09	.27711122E-10
.10422433E-11	-.47322329E-11	.23975455E-10	.12585346E-10	-.19775410E-08
.38697774E-08	.10379095E-08	-.52157042E-07	-.11489221E-06	-.17754025E-07
.21349168E+00	-.21187502E-01	.47810000E-08	-.85307615E-08	.68817988E-07
-.10708940E-06	.50448730E-10	-.46755022E-10	.30712267E-10	.33803654E-10
.15965556E-10	.69886272E-09	.12220632E-08	.21628280E-10	-.78725297E-11
-.17381897E-10	-.96488084E-10	-.19868499E-09	-.38323239E-08	-.47144921E-08
-.67436058E-09	.14619108E-07	-.33233900E-06	.51984276E-08	-.21187509E-01
.21349175E+00	-.42856447E-08	.35137127E-08	.33059276E-07	-.33370775E-06
.62597345E-10	-.21700140E-09	.25569023E-10	-.43772625E-10	-.89149742E-10
-.12003948E-09	.35860843E-08	.16675823E-09	.65427100E-12	-.12334270E-10
.23731088E-10	-.62821713E-09	.18497242E-08	-.91183816E-09	-.28036982E-10
.27364911E-09	.24570374E-07	.33154821E-08	.66093311E-08	-.59245192E-08
.29513290E+00	.37519809E-08	-.69733084E-08	.44873745E-07	.28192923E-11
-.19683526E-10	-.11199895E-12	.17068733E-10	-.10047449E-10	-.16608589E-10
-.39748348E-09	.16947454E-10	.21308173E-11	.12755192E-11	.12553181E-11
.67910129E-10	-.87066875E-08	-.27779292E-09	-.24417141E-08	-.28100677E-07
-.19598723E-07	.43669505E-07	-.17399277E-07	.71665128E-08	.55356311E-08
.43543590E+00	.14810812E-06	-.84720111E-07	.53455607E-09	-.10077465E-08
.39621050E-09	-.90142789E-10	.11631096E-09	.76132617E-09	.62634874E-09
-.96162869E-10	-.55908969E-11	.16693329E-10	-.13693987E-09	-.80752431E-10
.14274801E-06	.94331868E-07	.33459029E-08	.11065514E-07	-.30525020E-07
-.83883518E-07	.21959873E-06	.10549258E-06	-.16096458E-07	.23172014E-06
.68125418E+00	-.27104561E-01	.11614789E-08	.26490362E-08	-.31716511E-09
.85943274E-09	.90728701E-09	-.29221317E-08	.50490366E-09	-.31241205E-08
.51957049E-09	-.61526398E-09	-.73211418E-09	.41751702E-09	-.41815403E-07
-.62392289E-06	-.35367329E-07	.58996564E-08	.12062234E-07	.47779635E-07
-.34172432E-06	-.10648671E-05	.10358214E-06	-.13254778E-06	-.27104623E-01
.68125575E+00	.42582183E-08	.10332833E-07	.43797025E-09	-.43936896E-08
-.13188862E-07	.99646725E-09	-.27074259E-08	-.41693831E-08	.35204549E-09
.27946747E-08	.26429309E-10	-.19132813E-09	.54370530E-09	.12885390E-08
-.26094123E-10	.32796145E-08	-.75165501E-08	-.59794170E-08	.10704220E-08
.13302950E-08	.43492383E-10	.55578312E-08	.77190818E-08	.28298716E-07
.45273599E+01	.33289908E-09	.17573194E-09	.16686711E-09	.32812234E-09
-.13993111E-08	.35471410E-08	-.36583693E-09	.17545295E-10	-.23583057E-10
.19549301E-09	-.46399077E-09	-.68383088E-09	-.53715190E-08	.26488114E-09
.94548621E-08	-.25067621E-07	.16397539E-07	-.12751511E-08	-.59152219E-08
-.38826234E-09	-.13469743E-07	.22631843E-07	.88273977E-07	.42812130E-09
.58201288E+01	-.90943330E-09	-.36104962E-10	-.15585213E-08	-.61692245E-08
.16972432E-07	-.11689674E-08	.10556426E-09	.15428061E-09	.97207921E-09
-.19932091E-08	.84272535E-09	.12524416E-08	.42753780E-10	-.10640459E-08
-.19639654E-08	-.11067963E-07	.13620121E-08	.11243940E-08	-.22333246E-11
.86371992E-08	-.44220668E-08	.60963545E-08	.36836949E-09	-.14823860E-08
.94919248E+01	.11569532E-08	.14240477E-08	.23390508E-08	.39891144E-08
-.17362158E-08	.53773057E-10	-.69087488E-10	-.16684484E-09	-.30710330E-09
.23825826E-08	-.10705752E-08	-.36680513E-09	.71712112E-09	.25667901E-07
.29338338E-08	.20318696E-08	-.26286568E-08	.74191582E-09	-.26544722E-08
.16176156E-07	-.82690075E-07	.47275881E-09	-.79170095E-10	.15625947E-08
.12821483E+02	-.41877293E-03	-.56342791E-07	-.31992622E-06	.10454387E-08
.43863811E-09	.49179440E-09	.31556405E-09	.59403734E-08	.11999282E-08
-.29567965E-08	.11817227E-09	-.56627605E-08	.73391744E-07	-.38683881E-08
.95862784E-09	-.53555396E-08	-.43655302E-09	.34248007E-08	.17076716E-07
-.24822099E-06	.92912736E-09	-.34332976E-08	.19234540E-08	-.41877339E-03
.12821497E+02	.54236081E-07	-.93850374E-06	-.13387797E-07	-.18793480E-10
.94000040E-09	-.13067391E-08	.19214341E-07	.47846913E-07	.51256077E-08
-.22527256E-09	-.14182629E-07	-.10032981E-07	-.20366924E-07	.45262964E-07

```
-.77773881E-08 -.77815894E-09  .24176875E-07 -.59312892E-07  .20227043E-07
-.42740708E-08 -.14657279E-07  .34081278E-08 -.60764954E-07  .58492524E-07
 .13827771E+02  .21047759E-02 -.11938795E-06  .63495967E-08 -.28372832E-08
-.12322523E-07  .35987854E-08  .17313572E-07  .19380609E-06  .10627946E-07
-.69339030E-08  .12880785E-07 -.18128101E-07  .79148965E-07  .23226738E-06
-.18623154E-07  .19890436E-07  .10247543E-07 -.54955412E-07  .10833735E-07
 .40324285E-07  .58103208E-08 -.34503589E-06 -.10121617E-05  .21047783E-02
 .13827787E+02  .13394160E-06 -.30532164E-08 -.29475699E-07 -.23147128E-08
 .69566688E-08  .85737493E-09  .11972471E-07 -.52009481E-09 -.26582230E-07
 .30475180E-07  .54095867E-08  .16790539E-08  .13098546E-07  .95948868E-09
-.36975908E-08 -.76756243E-07 -.10244206E-06 -.13514731E-08 -.33636087E-08
-.30612494E-08  .13646379E-08 -.17478437E-07 -.14452064E-06  .16213823E-06
 .16738775E+02 -.13945359E-08 -.16103805E-08 -.12679180E-07  .10869214E-07
-.91550650E-09 -.33334156E-10 -.16050637E-09  .87776220E-08 -.46153852E-08
 .41203041E-09 -.12472661E-08  .11467520E-09  .24680008E-09 -.43801066E-09
 .25970692E-07  .17595245E-07  .13230540E-09  .61985082E-09  .19168201E-09
 .11644931E-08 -.49596044E-10  .15629549E-07 -.75152029E-08 -.28347009E-08
 .34035455E+02  .20067129E-03  .49914084E-06 -.29113677E-06 -.15969909E-08
-.27153113E-08 -.47502223E-10 -.33529005E-08 -.43896635E-07 -.18777036E-08
-.27762546E-08 -.19675833E-08  .14724131E-09  .13048872E-08 -.30742521E-07
 .13961746E-06 -.17783387E-09  .90098960E-09 -.24823965E-09  .13055799E-08
 .24952241E-08 -.69844069E-08 -.72550516E-07 -.32742397E-08  .20067151E-03
 .34035491E+02 -.20345508E-06 -.25713854E-05 -.17642842E-07 -.97773383E-09
 .14035968E-09 -.12931820E-07 -.88486304E-09  .95699556E-08 -.15492845E-07
 .38072643E-08  .14565520E-09 -.10781761E-07 -.36845727E-07  .13291458E-08
 .14814849E-08  .57271389E-08 -.60505547E-09  .84480496E-09 -.34929367E-08
-.30551212E-07 -.57376276E-08 -.25966143E-07  .50277715E-06 -.20493817E-06
 .34283278E+02 -.40681539E-02 -.57248771E-08 -.84432571E-07 -.45627666E-08
 .94143010E-08  .55387795E-08  .50248116E-08 -.31901744E-07 -.10086897E-06
 .78883295E-08 -.63574471E-08  .21010657E-07 -.96293667E-08 -.35136868E-08
-.11741684E-07 -.11054520E-08  .15883512E-07  .51376341E-07  .89214834E-08
 .17247322E-07  .22259068E-07 -.29325792E-06 -.25901072E-05 -.40681582E-02
 .34283314E+02
          *** zeroth order terms ***


 alpha
-.42285318E-07  .22032523E-08  .19103434E-08 -.46164709E-09 -.25254923E-07
 .15319234E-08 -.92689514E-10 -.41002187E-09 -.56423913E-10  .53935514E-09
 .39637933E-10 -.80781973E-09  .34687579E-10 -.27100970E-09  .57689693E-10
-.98124081E-10  .42222814E-08  .46766094E-10 -.23190343E-08 -.21012612E-09
 .84068331E-10  .67994729E-09 -.13698436E-08  .62753410E-10  .11096251E-10
 .39006386E-10  .73868759E-11  .27987870E-11 -.62247277E-09 -.59775470E-11
 .17590884E-09  .76219460E-11 -.26366890E-09  .11876573E-10  .28290161E-10
-.27201298E-10  .89869863E-12 -.15751250E-11 -.33157375E-12  .70866876E-12
-.24551181E-11 -.42785452E-10  .34373229E-12  .11944186E-12 -.30843212E-12
 .15203202E-10  .15923719E-12 -.27557073E-12 -.68722572E-12  .78199706E-11
-.53600279E-12  .35222275E-11 -.10833770E-12 -.38667210E-11  .24012255E-12
-.22349588E-13  .72325799E-13 -.72369183E-12  .14903493E-11  .24910814E-10
 .17123480E-11  .30860344E-13  .45896282E-13  .35510380E-13 -.12439625E-11
 .66833265E-13 -.45804903E-12 -.82105459E-14  .84237205E-12  .62945655E-13
-.81003566E-13  .43653901E-13
 h matrix
-.41919760E+00  .56538237E+00 -.43485534E-01 -.48726399E+01 -.14092839E+00
 .31621688E+00 -.15658688E+00 -.17361672E-01 -.21636943E-02 -.21186125E-01
 .26295445E+00  .10634541E-02  .39837270E+00  .24038060E-01  .34138213E-02
 .72810429E-01 -.66125938E-01 -.14508666E-01 -.87470672E-01  .13982584E-01
 .20325687E-02 -.26138318E+00 -.13271355E-01  .17000778E-01  .16625637E-01
-.30466702E-03  .92471384E-04 -.13678233E-01  .14351589E-01  .35179758E-02
 .18275688E-02  .81441214E-01  .37327408E-03 -.11565896E+00 -.94944608E-03
-.86128442E-03 -.44776941E-03 -.16313018E-03 -.15718717E-04 -.10522228E-02
 .90631992E-05  .49761828E-04 -.64926039E-04  .27152761E-04 -.19410130E-04
 .46028011E-03  .13453022E-03  .19224888E-06  .13666807E-02  .14309527E-03
-.11088438E-03 -.18934576E-03  .15159582E-02  .53961923E-05  .20500426E-02
 .20016096E-03  .90999899E-05  .44426853E-03  .45524403E-04  .33906200E-05
-.32663380E-04 -.43305067E-04 -.94350657E-07 -.31076189E-03  .13804808E-04
 .12272265E-04 -.36541686E-04 -.23880534E-03 -.33501440E-06 -.17757456E-03
-.13655382E-03 -.30751912E-05
 s1
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
```

```
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00
  *** first order terms ***

 i_1  m_i^b
 .89381792E-01  .00000000E+00  .00000000E+00  .00000000E+00  .89381792E-01
 .00000000E+00 -.58177179E+00 -.43307251E+00  .00000000E+00 -.10178988E+01
 .00000000E+00  .00000000E+00  .00000000E+00 -.10178988E+01  .00000000E+00
 .15376649E+00 -.50245233E+01  .00000000E+00  .71852291E-02  .00000000E+00
 .00000000E+00  .00000000E+00  .71852291E-02  .00000000E+00  .28424090E-01
-.17291849E+00  .00000000E+00 -.10551282E-01  .00000000E+00  .00000000E+00
 .00000000E+00 -.10551282E-01  .00000000E+00 -.40492477E+05 -.23515802E+04
 .00000000E+00 -.31408004E-01  .00000000E+00  .00000000E+00  .00000000E+00
-.31408004E-01  .00000000E+00  .22328507E+04 -.40498476E+05  .00000000E+00
 .33870978E+05  .00000000E+00  .00000000E+00  .00000000E+00  .33870978E+05
 .00000000E+00  .24388227E-01  .23658852E-01  .00000000E+00  .31851587E-01
 .00000000E+00  .00000000E+00  .00000000E+00  .31851587E-01  .00000000E+00
-.16187775E-01 -.96444085E-01  .00000000E+00 -.53418857E-01  .00000000E+00
 .00000000E+00  .00000000E+00 -.53418857E-01  .00000000E+00  .12105322E-01
-.28935991E+00  .00000000E+00 -.11132880E-03  .00000000E+00  .00000000E+00
 .00000000E+00 -.11132880E-03  .00000000E+00 -.11476862E-02  .30969398E-01
 .00000000E+00 -.22321987E+05  .00000000E+00  .00000000E+00  .00000000E+00
-.22321987E+05  .00000000E+00 -.31998031E-01 -.29477051E-01  .00000000E+00
 .11286377E-02  .00000000E+00  .00000000E+00  .00000000E+00  .11286377E-02
 .00000000E+00 -.59876589E+05 -.98431220E+04  .00000000E+00 -.35882781E-02
 .00000000E+00  .00000000E+00  .00000000E+00 -.35882781E-02  .00000000E+00
-.74530641E+04  .60220631E+05  .00000000E+00  .34407691E+06  .00000000E+00
 .00000000E+00  .00000000E+00  .34407691E+06  .00000000E+00 -.20702927E-04
 .84613530E-04  .00000000E+00 -.20271109E-05  .00000000E+00  .00000000E+00
 .00000000E+00 -.20271109E-05  .00000000E+00  .60214464E-02  .31309394E-02
 .00000000E+00  .21803208E+06  .00000000E+00  .00000000E+00  .00000000E+00
 .21803208E+06  .00000000E+00  .35046731E-06  .20448791E-05  .00000000E+00
```

```
 .13462938E+00   .00000000E+00   .00000000E+00   .00000000E+00   .13462938E+00
 .00000000E+00   .25977374E-05   .10399210E-03   .00000000E+00  -.81973301E-01
 .00000000E+00   .00000000E+00   .00000000E+00  -.81973301E-01   .00000000E+00
-.15155120E-04   .18537988E-03   .00000000E+00  -.55950132E-05   .00000000E+00
 .00000000E+00   .00000000E+00  -.55950132E-05   .00000000E+00  -.50422495E+04
-.40884484E+02   .00000000E+00  -.70074319E-03   .00000000E+00   .00000000E+00
 .00000000E+00  -.70074319E-03   .00000000E+00   .40113806E+02  -.50422499E+04
 .00000000E+00  -.10789343E-03   .00000000E+00   .00000000E+00   .00000000E+00
-.10789343E-03   .00000000E+00  -.15519734E-03   .54725953E-02   .00000000E+00
-.15473569E-01   .00000000E+00   .00000000E+00   .00000000E+00  -.15473569E-01
 .00000000E+00  -.44691498E-04   .61545868E-04   .00000000E+00  -.16490171E-01
 .00000000E+00   .00000000E+00   .00000000E+00  -.16490171E-01   .00000000E+00
 .70316673E-04   .10593837E-03   .00000000E+00  -.22504118E-05   .00000000E+00
 .00000000E+00   .00000000E+00  -.22504118E-05   .00000000E+00  -.30912152E+04
 .15565069E+04   .00000000E+00   .66447651E-04   .00000000E+00   .00000000E+00
 .00000000E+00   .66447651E-04   .00000000E+00  -.15561377E+04  -.30913985E+04
 .00000000E+00
gamma_2  y_ki^b
-.62607851E-07  -.50794938E-06   .17478712E-01   .51856264E-06  -.78861303E-08
-.10052474E+01  -.73381075E-03  -.13366523E-01   .45386799E-06   .36717330E-07
 .34244087E-06   .21280028E-06  -.34124540E-06   .38838113E-07  -.21262985E-06
-.33159527E-07   .43796371E-07  -.24642116E-05   .13404742E-06  -.82364180E-06
 .18701826E-02   .80726494E-06   .22112481E-06   .17620561E-01  -.53324649E-02
-.28274991E-01  -.60964083E-07   .18974310E-07  -.16027134E-07   .26374269E-06
 .21157972E-08  -.24413690E-06  -.10930903E-06  -.24235997E-06   .10887613E-07
-.13773702E-06  -.74355275E-06   .86344820E-06  -.86348556E-08  -.10594211E+00
-.72922176E-01   .12741219E-07  -.80583169E-06   .12968028E-05  -.14501437E-06
-.91143541E-07   .15942143E-06  -.12557840E+00  -.16085783E-06  -.84422487E-07
 .47379413E+00  -.16763984E-06  -.73009900E-06   .48745525E-06  -.27553639E-06
-.28304144E-05  -.20161874E-06  -.21301848E+00  -.18980035E+01  -.16449225E-07
-.15146456E-06  -.22667613E-06  -.27864015E+00  -.22686122E-06   .15001301E-06
-.75692354E+00   .85227134E-07   .54382657E-06  -.11012196E-05   .35436475E-07
 .14708492E-05   .62332048E-06  -.51856264E-06   .78861303E-08   .10052474E+01
 .38444042E-06  -.36081121E-07   .17478850E-01   .13382617E-01  -.32858247E-03
-.72393559E-07  -.19119526E-07  -.39108756E-06   .34672207E-05   .38988118E-06
-.19214899E-07  -.15281638E-07  -.38279177E-06  -.12413706E-07  -.11021283E-06
 .99446352E-07  -.60651059E-06  -.17943828E-01   .58761898E-06   .15995717E-06
 .31010888E-02   .28423613E-01  -.44735140E-02   .26039509E-08   .16609008E-06
 .45472414E-07   .37293498E-07  -.10498110E-06   .45860445E-06  -.93834662E-06
 .45908021E-06   .88219631E-07   .18403367E-06  -.78571358E-05  -.80752560E-06
-.22489195E-06   .76105503E-01  -.10368437E+00   .15769748E-08  -.10568617E-04
 .57565891E-06   .76217949E-06  -.74044170E-07   .11391547E-06  -.46976639E+00
-.12058674E-06  -.75683469E-07  -.13985513E+00   .10506104E-05   .54053200E-06
 .30253741E-05   .21515236E-05   .12619873E-06   .20116967E-05   .19035792E+01
-.15542683E+00  -.27743136E-08  -.12645160E-06  -.20146267E-06  -.74812742E+00
-.20000508E-06   .12631014E-06   .30143385E+00  -.10593951E-05  -.15030137E-05
-.77536846E-05   .10054546E-06  -.52218327E-06  -.39275247E-05   .73381075E-03
 .13366523E-01  -.45386799E-06  -.13382617E-01   .32858247E-03   .72393559E-07
 .54588498E-07  -.11666072E-07   .14310395E-13  -.71385118E-09   .88880863E-08
 .18767167E-06   .19211684E-08   .68511270E-09   .23711830E-07   .25343822E-07
-.10409501E-07   .56561332E-12  -.21846001E-01   .12358662E+00   .57679267E-07
-.12080850E+00  -.34003255E-01  -.19362683E-07  -.45282224E-07   .61839009E-08
 .75797873E-14   .13743203E-06   .22855908E-08  -.88236331E-13  -.28600792E-09
 .22856711E-07  -.87464909E-07  -.79568074E-08   .51110757E-09   .14175266E-07
-.23010227E-06  -.98727685E-07   .43416653E-13  -.24898360E-06   .91483883E-07
-.77664092E-13  -.45284969E-06   .42741722E-07  -.21249170E-12  -.13278546E-01
-.52285061E-01   .14719014E-06   .52285564E-01  -.13276810E-01  -.63399074E-08
-.26217801E-08  -.39483112E-08   .92799969E-07   .35017562E-08  -.20853839E-08
 .83171247E-07  -.65246642E-06   .17160470E-06  -.41382889E-12  -.23320671E-01
-.71358750E-01   .15696020E-06  -.71358882E-01   .23320214E-01  -.38814806E-07
 .47261019E-08   .11104159E-07  -.25209767E-06  -.82271192E-08   .34017979E-08
-.17927404E-06  -.36717330E-07  -.34244087E-06  -.21280028E-06   .19119526E-07
 .39108756E-06  -.34672207E-05   .71385118E-09  -.88880863E-08  -.18767167E-06
 .77264000E-09   .56089073E-08   .25542566E-01  -.54712968E-08   .45510576E-09
-.83092402E+00  -.28447933E-03   .22671016E-02  -.12113218E-05  -.56448434E-07
 .24611815E-06   .73965692E-06  -.24294989E-06  -.44164116E-07   .23229657E-05
-.35178955E-09  -.14722675E-07  -.16092113E-06   .65717217E-02   .49474668E-01
 .21395490E-06  -.14410719E-08  -.40903978E-08   .60441216E-01  -.11126326E-08
 .49737407E-08  -.53923648E+00  -.94714179E-01  -.64899273E+00  -.34678836E-08
-.10559694E-07  -.39960159E-06   .37782460E-06   .13940018E+00   .12146079E+01
-.12958433E-08   .19372121E-06   .13219075E-05   .14943658E-08   .80698553E-07
```

-.19053734E-06	.77887080E-07	.39680923E-08	.64423900E-08	.19692464E-01
-.67860925E-08	.11108030E-08	-.36522737E-04	-.71710619E-08	-.46661594E-06
.20025118E-06	.65869035E-07	.31119132E-06	-.19170180E-07	-.48891040E-08
-.41439984E-06	-.18152134E-07	-.76837879E-08	-.16366625E-07	-.11419001E+00
.16399263E-07	-.73058140E-08	.94493068E-01	.34124540E-06	-.38838113E-07
.21262985E-06	-.38988118E-06	.19214899E-07	.15281638E-07	-.19211684E-08
-.68511270E-09	-.23711830E-07	.54712968E-08	-.45510576E-09	.83092402E+00
-.17031265E-07	.24014354E-08	.25542495E-01	-.22678700E-02	-.27782968E-03
.11184452E-05	.62194659E-07	-.47712538E-06	-.76244129E-07	.43215597E-06
.10569704E-06	.33350487E-07	-.71735340E-08	-.38147924E-09	.10918412E-07
-.49455263E-01	.67166526E-02	-.25146107E-06	-.93566548E-09	-.57381558E-08
-.53707875E+00	-.90587906E-08	.40903232E-08	-.40597617E-01	.64871410E+00
-.96615212E-01	-.60262836E-09	-.18891624E-06	-.98396479E-08	.89202189E-07
-.12141936E+01	.14295856E+00	.23050185E-09	-.14209128E-05	.23416354E-06
.35761913E-07	.15420580E-06	-.19440207E-07	.14128991E-08	.11873660E-07
.19292084E-07	.96879863E-04	-.16434235E-07	.11524456E-07	.19691541E-01
-.22074571E-06	-.15404011E-07	-.27221783E-06	-.28954207E-06	.78314182E-07
.29898828E-08	.42591726E-06	-.27558297E-07	-.32855064E-08	-.22910605E-07
-.48721700E-07	-.94812449E-01	.48349038E-07	-.22872252E-07	-.11390138E+00
.33159527E-07	-.43796371E-07	.24642116E-05	.38279177E-06	.12413706E-07
.11021283E-06	-.25343822E-07	.10409501E-07	-.56561332E-12	.28447933E-03
-.22671016E-02	.12113218E-05	.22678700E-02	.27782968E-03	-.11184452E-05
-.38364585E-09	-.37498631E-08	.35516869E-12	-.22295994E-07	-.84358887E-08
-.17454190E-05	-.61060311E-07	.22204943E-07	.56177629E-06	.13463461E-06
-.14755869E-07	-.18433634E-12	-.72183338E-07	.90190096E-07	-.75307473E-13
.36174635E-02	.19730933E-01	-.68628116E-06	.19571357E-01	-.43996180E-02
-.78227017E-06	.96672133E-06	-.11372652E-05	-.81782833E-13	.37524982E-05
-.34633772E-06	.73163584E-12	-.14240023E-05	.16913358E-05	.85314857E-12
-.30146541E-08	.35978002E-08	-.45661113E-06	-.42909184E-08	-.19153162E-08
.50616539E-07	-.12756037E-01	-.20183313E-01	-.54931006E-07	.20181394E-01
-.12759081E-01	.42808564E-07	.36247494E-05	-.29293728E-06	-.11631316E-12
-.31447785E-08	-.59196241E-08	.10223336E-07	-.49032229E-08	.29885627E-08
.83085912E-07	.26910936E-01	.53138454E-01	-.10396571E-06	-.53141657E-01
.26904645E-01	-.94708623E-07	-.13404742E-06	.82364180E-06	-.18701826E-02
-.99446352E-07	.60651059E-06	.17943828E-01	.21846001E-01	-.12358662E+00
-.57679267E-07	.56448434E-07	-.24611815E-06	-.73965692E-06	-.62194659E-07
.47712538E-06	.76244129E-07	.22295994E-07	.84358887E-08	.17454190E-05
.47263847E-08	-.24842569E-07	-.74612173E-02	.33702520E-07	.52587698E-08
-.99165381E+00	-.24130997E-02	.27251892E-01	-.20230691E-06	.42383207E-07
-.11484143E-07	.90215619E-06	-.40538688E-08	.59415338E-07	.40772390E-06
-.88506639E-09	-.26291127E-07	.93122118E-07	-.70112029E-06	.18615170E-06
-.27093746E-06	-.11513953E+00	.10016519E+01	.10444111E-07	.66967927E-06
-.22081894E-06	.29618344E-06	-.36225913E-08	.85213715E-08	-.40353386E-01
-.80313089E-08	-.50214583E-08	.13026438E+00	-.79053746E-07	.70869914E-06
.84282940E-07	.96353235E-10	.81235041E-06	.18225686E-07	.92446699E-02
.36511561E+00	-.12675867E-07	-.57668967E-08	-.84437859E-08	-.19320351E-01
-.83112891E-08	.55592945E-08	-.12118342E+00	.37021885E-07	-.17801169E-06
-.12499195E-06	-.55451004E-07	-.26193636E-06	.18332552E-07	-.80726494E-06
-.22112481E-06	-.17620561E-01	-.58761898E-06	-.15995717E-06	-.31010888E-02
.12080850E+00	.34003255E-01	.19362683E-07	.24294989E-06	.44164116E-07
-.23229657E-05	-.43215597E-06	-.10569704E-06	-.33350487E-07	.61060311E-07
-.22204943E-07	-.56177629E-06	-.33702520E-07	-.52587698E-08	.99165381E+00
.19757764E-07	.81710904E-08	-.74615305E-02	-.26877854E-01	-.51057423E-02
.67961445E-07	.12974058E-06	-.90406751E-08	-.26684890E-06	-.65884970E-07
.26442837E-06	.13464373E-05	.30067542E-06	-.20275997E-08	.86886469E-07
-.21444915E-05	.11187428E-06	-.77099669E-07	-.98527966E+00	-.21397787E+00
-.14263427E-08	.20740004E-05	-.23288741E-06	.46545419E-07	.87483772E-09
.17211154E-07	-.12561504E+00	-.15869406E-07	.14981146E-08	-.53077809E-01
-.69826092E-06	-.93248306E-07	.23220378E-06	-.86409724E-06	-.81421980E-07
.11449558E-06	-.36422996E+00	-.27036148E-01	.14001264E-08	.48725385E-08
.12206505E-07	-.11866768E+00	.12399628E-07	-.47190946E-08	.31250391E-01
.23088390E-06	-.32957092E-07	-.37125093E-06	.35360159E-06	.28254188E-07
-.38520272E-07	.53324649E-02	.28274991E-01	.60964083E-07	-.28423613E-01
.44735140E-02	-.26039509E-08	.45282224E-07	-.61839009E-08	-.75797873E-14
.35178955E-09	.14722675E-07	.16092113E-06	.71735340E-08	.38147924E-09
-.10918412E-07	-.13463461E-06	.14755869E-07	.18433634E-12	.24130997E-02
-.27251892E-01	.20230691E-06	.26877854E-01	.51057423E-02	-.67961445E-07
-.19610946E-09	-.12793244E-08	-.40284160E-14	-.83006278E-07	.16727198E-07
-.31503409E-13	-.12027390E-08	-.79489702E-08	-.94373911E-07	-.70395759E-09
-.24600259E-09	-.61037343E-08	.20879089E-06	-.14299961E-07	-.29220077E-13
-.15107758E-06	.17930787E-07	.35600382E-13	-.18459429E-06	.73257490E-07

.32197615E-13	-.11934809E-01	-.24773363E-01	-.28562365E-07	.24773764E-01
-.11933949E-01	.10299928E-08	.93398544E-10	.13727412E-09	-.23093011E-07
-.54977989E-09	.38611032E-09	-.12072820E-07	-.34175860E-07	.90726267E-08
.25781137E-13	-.30017386E-01	-.48004147E-01	-.21394263E-07	-.48004340E-01
.30017176E-01	-.16597444E-08	.15204283E-09	-.22344016E-10	.41855726E-07
.19779770E-08	-.13203123E-08	.89135235E-08	-.18974310E-07	.16027134E-07
-.26374269E-06	-.16609008E-06	-.45472414E-07	-.37293498E-07	-.13743203E-06
-.22855908E-08	.88236331E-13	-.65717217E-02	-.49474668E-01	-.21395490E-06
.49455263E-01	-.67166526E-02	.25146107E-06	.72183338E-07	-.90190096E-07
.75307473E-13	-.42383207E-07	.11484143E-07	-.90215619E-06	-.12974058E-06
.90406751E-08	.26684890E-06	.83006278E-07	-.16727198E-07	.31503409E-13
.10960857E-07	-.12663272E-07	-.12636246E-13	-.19959259E-02	.72617544E-01
.79350189E-07	.72639356E-01	-.89484432E-03	.11343359E-06	-.16459085E-06
.21258826E-06	.17755656E-12	.50741177E-06	-.65700277E-07	-.13810761E-12
.12668197E-06	-.19034335E-06	-.24898461E-12	.48485096E-09	-.38632258E-09
.20325780E-06	.53522249E-09	.18948680E-10	.27623676E-08	.84150598E-02
.17168433E-01	.34115338E-07	-.17167179E-01	.84177208E-02	-.13940941E-07
-.51059035E-07	-.57298172E-07	.20698406E-13	.94233533E-10	.50069943E-09
.11013082E-06	.50976879E-11	-.19275352E-09	.15874235E-08	-.41887505E-02
-.31354146E-01	-.46431865E-07	.31354628E-01	-.41849538E-02	.36824273E-07
-.21157972E-08	.24413690E-06	.10930903E-06	.10498110E-06	-.45860445E-06
.93834662E-06	.28600792E-09	-.22856711E-07	.87464909E-07	.14410719E-08
.40903978E-08	-.60441216E-01	.93566548E-09	.57381558E-08	.53707875E+00
-.36174635E-02	-.19730933E-01	.68628116E-06	.40538688E-08	-.59415338E-07
-.40772390E-06	.65884970E-07	-.26442837E-06	-.13464373E-05	.12027390E-08
.79489702E-08	.94373911E-07	.19959259E-02	-.72617544E-01	-.79350189E-07
-.70696657E-10	.59061577E-09	.15406909E-02	-.20017513E-08	-.22674296E-08
.18271839E+00	-.29420640E-01	.35553316E+00	.10890627E-08	-.22036796E-08
.72972846E-07	-.18535266E-06	.15383984E-02	-.28931664E+00	.30106500E-09
.35186887E-07	-.34894224E-06	-.12497649E-08	-.41746864E-07	.22875467E-07
.45437189E-07	-.42673819E-09	-.78136072E-09	.29073755E-01	.83848781E-09
-.30068531E-10	-.41762028E-01	.54019335E-08	-.52857311E-07	.69439023E-07
.39767875E-07	.76296204E-08	-.21121434E-08	.11553120E-06	.45920329E-07
-.21718772E-07	.44647683E-09	.16416114E-08	-.28098883E-01	-.16609482E-08
.44578552E-09	.79066663E-01	.24235997E-06	-.10887613E-07	.13773702E-06
-.45908021E-06	-.88219631E-07	-.18403367E-06	.79568074E-08	-.51110757E-09
-.14175266E-07	.11126326E-08	-.49737407E-08	.53923648E+00	.90587906E-08
-.40903232E-08	.40597617E-01	-.19571357E-01	.43996180E-02	.78227017E-06
.88506639E-09	.26291127E-07	-.93122118E-07	-.30067542E-06	.20275997E-08
-.86886469E-07	.70395759E-09	.24600259E-09	.61037343E-08	-.72639356E-01
.89484432E-03	-.11343359E-06	.20017513E-08	.22674296E-08	-.18271839E+00
-.15690317E-08	.10989807E-09	.15406299E-02	.35642111E+00	.15252056E-01
-.15551538E-09	.11525644E-08	.22841308E-08	.53271028E-07	-.28914783E+00
.99735803E-02	-.80529120E-11	-.39209234E-06	.26942708E-07	-.40357060E-08
-.23699116E-07	-.12256696E-08	.39578955E-08	.13718954E-08	.23672818E-08
-.42889921E-01	-.19728023E-08	.12993543E-08	-.27395597E-01	.10482756E-07
-.36015513E-08	.59618938E-07	-.98494637E-07	.30215091E-07	.83151351E-09
.11154142E-06	-.12729912E-07	-.22012824E-08	-.20575968E-08	-.54136933E-08
.80118470E-01	.54141545E-08	-.20376560E-08	.24921274E-01	.74355275E-06
-.86344820E-06	.86348556E-08	.78571358E-05	.80752560E-06	.22489195E-06
.23010227E-06	.98727685E-07	-.43416653E-13	.94714179E-01	.64899273E+00
.34678836E-08	-.64871410E+00	.96615212E-01	.60262836E-09	-.96672133E-06
.11372652E-05	.81782833E-13	.70112029E-06	-.18615170E-06	.27093746E-06
.21444915E-05	-.11187428E-06	.77099669E-07	-.20879089E-06	.14299961E-07
.29220077E-13	.16459085E-06	-.21258826E-06	-.17755656E-12	.29420640E-01
-.35553316E+00	-.10890627E-08	-.35642111E+00	-.15252056E-01	.15551538E-09
.19702911E-08	.17067919E-09	-.67397229E-14	.43502667E-06	.23008021E-06
-.18534110E-15	-.31921334E-09	-.49233010E-09	-.98795752E-14	-.46272789E-08
.32747580E-08	.41693501E-08	-.86543027E-08	.51209400E-08	-.21513879E-08
-.12962772E+00	-.22610792E+00	-.55780767E-10	.22608848E+00	-.12966222E+00
-.46893542E-10	-.63686977E-06	.54634427E-06	.37138548E-15	.86753266E-08
.74221774E-08	.46945470E-08	.16797908E-07	-.91574736E-08	.19556552E-08
.19954144E+00	.51982556E+00	.11311457E-09	-.51984922E+00	.19947944E+00
.51066096E-10	.10594211E+00	.72922176E-01	-.12741219E-07	-.76105503E-01
.10368437E+00	-.15769748E-08	.24898360E-06	-.91483883E-07	.77664092E-13
.10559694E-07	.39960159E-06	-.37782460E-06	.18891624E-06	.98396479E-08
-.89202189E-07	-.37524982E-05	.34633772E-06	-.73163584E-12	.11513953E+00
-.10016519E+01	-.10444111E-07	.98527966E+00	.21397787E+00	.14263427E-08
.15107758E-06	-.17930787E-07	-.35600382E-13	-.50741177E-06	.65700277E-07
.13810761E-12	.22036796E-08	-.72972846E-07	.18535266E-06	-.11525644E-08
-.22841308E-08	-.53271028E-07	-.43502667E-06	-.23008021E-06	.18534110E-15

-.12392972E-07	-.12119306E-08	-.18085362E-13	-.25448515E-06	-.24080342E-06
-.72100480E-15	.42365812E-01	.22743214E+00	.53395066E-09	-.22743389E+00
.42358362E-01	.13756098E-09	-.34009417E-09	-.36617465E-08	-.44502412E-08
.50488788E-08	-.25689226E-08	.32032115E-08	.14881036E-07	.20788290E-08
-.53416876E-14	.49700530E-01	.27168256E+00	.17278504E-09	.27168278E+00
-.49698521E-01	-.46204715E-10	-.72402280E-09	-.51155317E-09	.66103844E-08
-.10387562E-07	.27226537E-08	-.73095770E-08	.80583169E-06	-.12968028E-05
.14501437E-06	.10568617E-04	-.57565891E-06	-.76217949E-06	.45284969E-06
-.42741722E-07	.21249170E-12	-.13940018E+00	-.12146079E+01	.12958433E-08
.12141936E+01	-.14295856E+00	-.23050185E-09	.14240023E-05	-.16913358E-05
-.85314857E-12	-.66967927E-06	.22081894E-06	-.29618344E-06	-.20740004E-05
.23288741E-06	-.46545419E-07	.18459429E-06	-.73257490E-07	-.32197615E-13
-.12668197E-06	.19034335E-06	.24898461E-12	-.15383984E-02	.28931664E+00
-.30106500E-09	.28914783E+00	-.99735803E-02	.80529120E-11	.31921334E-09
.49233010E-09	.98795752E-14	.25448515E-06	.24080342E-06	.72100480E-15
.80857846E-09	-.65913199E-09	-.89837874E-14	-.40276693E-08	.23299565E-08
.33531355E-09	-.74204357E-08	.35521019E-08	.62833350E-08	-.82095560E-01
-.12224359E+00	-.26190706E-11	.12223122E+00	-.82113856E-01	-.75550354E-12
-.49434274E-06	.52138355E-06	-.36084625E-15	.72258733E-08	.45094717E-08
.82984545E-09	.11398262E-07	-.86245755E-08	-.84823258E-08	.20012965E+00
.34933873E+00	.29523672E-11	-.34936258E+00	.20008846E+00	-.35514320E-11
.91143541E-07	-.15942143E-06	.12557840E+00	.74044170E-07	-.11391547E-06
.46976639E+00	.13278546E-01	.52285061E-01	-.14719014E-06	-.19372121E-06
-.13219075E-05	-.14943658E-08	.14209128E-05	-.23416354E-06	-.35761913E-07
.30146541E-08	-.35978002E-08	.45661113E-06	.36225913E-08	-.85213715E-08
.40353386E-01	-.87483772E-09	-.17211154E-07	.12561504E+00	.11934809E-01
.24773363E-01	.28562365E-07	-.48485096E-09	.38632258E-09	-.20325780E-06
-.35186887E-07	.34894224E-06	.12497649E-08	.39209234E-06	-.26942708E-07
.40357060E-08	.46272789E-08	-.32747580E-08	-.41693501E-08	-.42365812E-01
-.22743214E+00	-.53395066E-09	.40276693E-08	-.23299565E-08	-.33531355E-09
-.13190608E-09	-.42992791E-09	.53549523E-03	.44221408E-09	-.15144278E-09
-.50250104E-02	-.53621168E-07	-.78323735E-07	-.76419772E-10	.67488837E-07
-.40301963E-07	.71900559E-10	-.38245326E-02	.95707833E-02	.28472227E-09
-.26263013E-09	-.59806850E-09	.30586106E-02	-.60005167E-09	.27669342E-09
.65749091E-02	.13037445E-06	.21701737E-06	.12705909E-09	-.21430064E-06
.12189418E-06	-.18933107E-09	.16085783E-06	.84422487E-07	-.47379413E+00
.12058674E-06	.75683469E-07	.13985513E+00	-.52285564E-01	.13276810E-01
.63399074E-08	-.80698553E-07	.19053734E-06	-.77887080E-07	-.15420580E-06
.19440207E-07	-.14128991E-08	.42909184E-08	.19153162E-08	-.50616539E-07
.80313089E-08	.50214583E-08	-.13026438E+00	.15869406E-07	-.14981146E-08
.53077809E-01	-.24773764E-01	.11933949E-01	-.10299928E-08	-.53522249E-09
-.18948680E-10	-.27623676E-08	.41746864E-07	-.22875467E-07	-.45437189E-07
.23699116E-07	.12256696E-08	-.39578955E-08	.86543027E-08	-.51209400E-08
.21513879E-08	.22743389E+00	-.42358362E-01	-.13756098E-09	.74204357E-08
-.35521019E-08	-.62833350E-08	-.44221408E-09	.15144278E-09	.50250104E-02
-.10011899E-08	.39672401E-09	.53548366E-03	.35302623E-07	.45619868E-07
-.18324191E-09	-.58945067E-07	.24482274E-07	-.14363279E-09	-.95706411E-02
-.38248253E-02	.52950837E-10	.80178997E-09	.17350601E-08	.65747891E-02
.17209949E-08	-.80376640E-09	-.30587738E-02	-.65962710E-07	-.12765379E-06
.24445245E-09	.13611625E-06	-.63215067E-07	.27202374E-09	.16763984E-06
.73009900E-06	-.48745525E-06	-.10506104E-05	-.54053200E-06	-.30253741E-05
.26217801E-08	.39483112E-08	-.92799969E-07	-.39680923E-08	-.64423900E-08
-.19692464E-01	-.11873660E-07	-.19292084E-07	-.96879863E-04	.12756037E-01
.20183313E-01	.54931006E-07	.79053746E-07	-.70869914E-06	-.84282940E-07
.69826092E-06	.93248306E-07	-.23220378E-06	-.93398544E-10	-.13727412E-09
.23093011E-07	-.84150598E-02	-.17168433E-01	-.34115338E-07	.42673819E-09
.78136072E-09	-.29073755E-01	-.13718954E-08	-.23672818E-08	.42889921E-01
.12962772E+00	.22610792E+00	.55780767E-10	.34009417E-09	.36617465E-08
.44502412E-08	.82095560E-01	.12224359E+00	.26190706E-11	.53621168E-07
.78323735E-07	.76419772E-10	-.35302623E-07	-.45619868E-07	.18324191E-09
.16412533E-11	.21384164E-11	.32021163E-03	.58936241E-11	-.14505988E-10
-.33385669E-02	-.42306378E-10	-.13863650E-08	.83012671E-08	-.56730240E-07
-.96467007E-07	-.10535633E-09	-.91711930E-07	.55460535E-07	-.51525169E-09
-.43381873E-11	-.92974491E-11	-.29258756E-02	.76083731E-11	.16981023E-11
.72526267E-02	.27553639E-06	.28304144E-05	.20161874E-06	-.21515236E-05
-.12619873E-06	-.20116967E-05	-.35017562E-08	.20853839E-08	-.83171247E-07
.67860925E-08	-.11108030E-08	.36522737E-04	.16434235E-07	-.11524456E-07
-.19691541E-01	-.20181394E-01	.12759081E-01	-.42808564E-07	-.96353235E-10
-.81235041E-06	-.18225686E-07	.86409724E-06	.81421980E-07	-.11449558E-06
.54977989E-09	-.38611032E-09	.12072820E-07	.17167179E-01	-.84177208E-02
.13940941E-07	-.83848781E-09	.30068531E-10	.41762028E-01	.19728023E-08

-.12993543E-08	.27395597E-01	-.22608848E+00	.12966222E+00	.46893542E-10
-.50488788E-08	.25689226E-08	-.32032115E-08	-.12223122E+00	.82113856E-01
.75550354E-12	-.67488837E-07	.40301963E-07	-.71900559E-10	.58945067E-07
-.24482274E-07	.14363279E-09	-.58936241E-11	.14505988E-10	.33385669E-02
-.45134366E-09	.30239391E-09	.32020344E-03	.31906173E-09	.34199546E-11
-.81669645E-08	-.30329414E-06	-.66271809E-06	-.35363609E-09	-.66144997E-06
.30804574E-06	.20159786E-09	-.57170319E-09	-.11035564E-08	-.72527212E-02
.10976139E-08	-.57328140E-09	-.29238966E-02	.21301848E+00	.18980035E+01
.16449225E-07	-.19035792E+01	.15542683E+00	.27743136E-08	.65246642E-06
-.17160470E-06	.41382889E-12	.71710619E-08	.46661594E-06	-.20025118E-06
.22074571E-06	.15404011E-07	.27221783E-06	-.36247494E-05	.29293728E-06
.11631316E-12	-.92446699E-02	-.36511561E+00	.12675867E-07	.36422996E+00
.27036148E-01	-.14001264E-08	.34175860E-07	-.90726267E-08	-.25781137E-13
.51059035E-07	.57298172E-07	-.20698406E-13	-.54019335E-08	.52857311E-07
-.69439023E-07	-.10482756E-07	.36015513E-08	-.59618938E-07	.63686977E-06
-.54634427E-06	-.37138548E-15	-.14881036E-07	-.20788290E-08	.53416876E-14
.49434274E-06	-.52138355E-06	.36084625E-15	.38245326E-02	-.95707833E-02
-.28472227E-09	.95706411E-02	.38248253E-02	-.52950837E-10	.42306378E-10
.13863650E-08	-.83012671E-08	-.31906173E-09	-.34199546E-11	.81669645E-08
-.87485007E-08	-.13865777E-08	.21238779E-14	-.17696591E+00	-.39083612E+00
-.84602464E-10	-.39083720E+00	.17696374E+00	.30775127E-10	.12256099E-08
.79443691E-09	.63405973E-08	.15032889E-07	-.80204827E-08	.24197572E-08
.15146456E-06	.22667613E-06	.27864015E+00	.12645160E-06	.20146267E-06
.74812742E+00	.23320671E-01	.71358750E-01	-.15696020E-06	-.65869035E-07
-.31119132E-06	.19170180E-07	.28954207E-06	-.78314182E-07	-.29898828E-08
.31447785E-08	.59196241E-08	-.10223336E-07	.57668967E-08	.84437859E-08
.19320351E-01	-.48725385E-08	-.12206505E-07	.11866768E+00	.30017386E-01
.48004147E-01	.21394263E-07	-.94233533E-10	-.50069943E-09	-.11013082E-06
-.39767875E-07	-.76296204E-08	.21121434E-08	.98494637E-07	-.30215091E-07
-.83151351E-09	-.86753266E-08	-.74221774E-08	-.46945470E-08	-.49700530E-01
-.27168256E+00	-.17278504E-09	-.72258733E-08	-.45094717E-08	-.82984545E-09
.26263013E-09	.59806850E-09	-.30586106E-02	-.80178997E-09	-.17350601E-08
-.65747891E-02	.56730240E-07	.96467007E-07	.10535633E-09	.30329414E-06
.66271809E-06	.35363609E-09	.17696591E+00	.39083612E+00	.84602464E-10
.34515937E-11	.11639133E-10	.11823240E-03	.78122412E-12	-.14089096E-10
-.72836582E-02	-.46789915E-08	-.15892413E-07	.65356843E-10	.31383227E-07
.10485630E-07	.42666551E-09	.22686122E-06	-.15001301E-06	.75692354E+00
.20000508E-06	-.12631014E-06	-.30143385E+00	.71358882E-01	-.23320214E-01
.38814806E-07	.48891040E-08	.41439984E-06	.18152134E-07	-.42591726E-06
.27558297E-07	.32855064E-08	.49032229E-08	-.29885627E-08	-.83085912E-07
.83112891E-08	-.55592945E-08	.12118342E+00	-.12399628E-07	.47190946E-08
-.31250391E-01	.48004340E-01	-.30017176E-01	.16597444E-08	-.50976879E-11
.19275352E-09	-.15874235E-08	-.11553120E-06	-.45920329E-07	.21718772E-07
-.11154142E-06	.12729912E-07	.22012824E-08	-.16797908E-07	.91574736E-08
-.19556552E-08	-.27168278E+00	.49698521E-01	.46204715E-10	-.11398262E-07
.86245755E-08	.84823258E-08	.60005167E-09	-.27669342E-09	-.65749091E-02
-.17209949E-08	.80376640E-09	.30587738E-02	.91711930E-07	-.55460535E-07
.51525169E-09	.66144997E-06	-.30804574E-06	-.20159786E-09	.39083720E+00
-.17696374E+00	-.30775127E-10	-.78122412E-12	.14089096E-10	.72836582E-02
-.14618963E-09	.69521649E-10	.11823684E-03	-.73228149E-08	-.29478674E-07
.22679544E-09	.44642344E-07	-.22809491E-07	.59107460E-10	-.85227134E-07
-.54382657E-06	.11012196E-05	.10593951E-05	.15030137E-05	.77536846E-05
-.47261019E-08	-.11104159E-07	.25209767E-06	.76837879E-08	.16366625E-07
.11419001E+00	.22910605E-07	.48721700E-07	.94812449E-01	-.26910936E-01
-.53138454E-01	.10396571E-06	-.37021885E-07	.17801169E-06	.12499195E-06
-.23088390E-06	.32957092E-07	.37125093E-06	-.15204283E-09	.22344016E-10
-.41855726E-07	.41887505E-02	.31354146E-01	.46431865E-07	-.44647683E-09
-.16416114E-08	.28098883E-01	.20575968E-08	.54136933E-08	-.80118470E-01
-.19954144E+00	-.51982556E+00	-.11311457E-09	.72402280E-09	.51155317E-09
-.66103844E-08	-.20012965E+00	-.34933873E+00	-.29523672E-11	-.13037445E-06
-.21701737E-06	-.12705909E-09	.65962710E-07	.12765379E-06	-.24445245E-09
.43381873E-11	.92974491E-11	.29258756E-02	.57170319E-09	.11035564E-08
.72527212E-02	-.12256099E-08	-.79443691E-09	-.63405973E-08	.46789915E-08
.15892413E-07	-.65356843E-10	.73228149E-08	.29478674E-07	-.22679544E-09
-.20205244E-11	-.39891324E-11	.87155679E-04	.84364044E-11	.86915796E-11
.68614717E-02	-.35436475E-07	-.14708492E-05	-.62332048E-06	-.10054546E-06
.52218327E-06	.39275247E-05	.82271192E-08	-.34017979E-08	.17927404E-06
-.16399263E-07	.73058140E-08	-.94493068E-01	-.48349038E-07	.22872252E-07
.11390138E+00	.53141657E-01	-.26904645E-01	.94708623E-07	.55451004E-07
.26193636E-06	-.18332552E-07	-.35360159E-06	-.28254188E-07	.38520272E-07
-.19779770E-08	.13203123E-08	-.89135235E-08	-.31354628E-01	.41849538E-02

```
 -.36824273E-07  .16609482E-08 -.44578552E-09 -.79066663E-01 -.54141545E-08
  .20376560E-08 -.24921274E-01  .51984922E+00 -.19947944E+00 -.51066096E-10
  .10387562E-07 -.27226537E-08  .73095770E-08  .34936258E+00 -.20008846E+00
  .35514320E-11  .21430064E-06 -.12189418E-06  .18933107E-09 -.13611625E-06
  .63215067E-07 -.27202374E-09 -.76083731E-11 -.16981023E-11 -.72526267E-02
 -.10976139E-08  .57328140E-09  .29238966E-02 -.15032889E-07  .80204827E-08
 -.24197572E-08 -.31383227E-07 -.10485630E-07 -.42666551E-09 -.44642344E-07
  .22809491E-07 -.59107460E-10 -.84364044E-11 -.86915796E-11 -.68614717E-02
 -.10375733E-09  .53480837E-10  .87160403E-04
 kdyic1
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00
 rvtor1
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
  .00000000E+00  .00000000E+00
 svtor2
```

```
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
 .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00  .00000000E+00
```

(and more)

isc3_flex_verneq.int (Concept 3) Vernal Equinox

```
TREETOPS REV 10P2  4/10/00

            SIM CONTROL

  1 SI   0 Title                                                ISC MODEL, THIRD VERSION
  2 SI   0 Simulation stop time                                 1000000
  3 SI   0 Plot data interval                                   20
  4 SI   0 Integration type (R,S,U, OR V)                       R
  5 SI   0 Step size (sec)                                      .1
  6 SI   0 Sandia ODE solver absolute and relative error
  7 SI   0 RK78 ODE solver absolute error and first step size
  8 SI   0 Linearization option  (L,Z or N)                     N
  9 SI   0 Restart option         (Y/N)                         N
 10 SI   0 Contact force computation option     (Y/N)           Y
 11 SI   0 Constraint force computation option  (Y/N)           N
 12 SI   0 Small angle speedup option (All,Bypass,First,Nth)    A
 13 SI   0 Mass matrix speedup option (All,Bypass,First,Nth)    A
 14 SI   0 Non-Linear  speedup option (All,Bypass,First,Nth)    A
 15 SI   0 Constraint  speedup option (All,Bypass,First,Nth)    A
 16 SI   0 Constraint stabilization option  (Y/N)               N
 17 SI   0 Stabilization epsilon


            GENGRAV

 18 GG   4 Gravity, earth sphere/nonsphere/user (S/N/U)?         N
 19 GG   1 Input gravity constants:  GME, ERAD, EMASS
 20 GG   1 Spherical or Nonspherical (S/N)?
 21 GG   1 Gravity Potential Harmonics J2,J3,J4
 22 GG   4 English (ft-slug-s) or metric (m-kg-s)    (E/M)?     M
 23 GG   4 Day, Month, Year,                                    20 3 2020
 24 GG   4 GMT @ sim time 0 (minutes past midnight,             360
 25 GG   4 Solar Pressure forces Y/N?                           Y
 26 GG   4 Input new data for aero model? (Y/N)                 N
 27 GG   1   Solar flux F10 for aero model
 28 GG   1   Solar flux, 81 day average F10B
 29 GG   1   Geomagnetic index, GEAP


            BODY

 30 BO   1 Body ID number                                       1
 31 BO   1 Type (Rigid,Flexible,NASTRAN)                        F
 32 BO   1 Number of modes                                      24
 33 BO   1 Modal calculation option (0, 1 or 2)                 2
 34 BO   1 Foreshortening option (Y/N)
 35 BO   1 Model reduction method (NO,MS,MC,CC,QM,CV)
 36 BO   1 NASTRAN data file FORTRAN unit number (40 - 60)
 37 BO   1 Number of augmented nodes (0 if none)
 38 BO   1 Damping matrix option (NS,CD,HL,SD)
 39 BO   1 Constant damping ratio
 40 BO   1 Low frequency, High frequency ratios
 41 BO   1 Mode ID number, damping ratio
 42 BO   1 Conversion factors: Length,Mass,Force
 43 BO   1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
```

```
 44 BO   1 Moments of inertia (kg-m2) Ixx,Iyy,Izz              6.2852173E11 6.2852173E11
6.7057352E8
 45 BO   1 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 46 BO   1 Mass (kg)                                           1.6168633E5
 47 BO   1 Number of Nodes                                     4
 48 BO   1 Node ID, Node coord. (meters) x,y,z                 1 0 0 0
 49 BO   1 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
 50 BO   1 Node ID, Node coord. (meters) x,y,z                 3 0 0 3188.8
 51 BO   1 Node ID, Node coord. (meters) x,y,z                 4 0 0 -3188.8
 52 BO   1 Node ID, Node structual joint ID

 53 BO   2 Body ID number                                      2
 54 BO   2 Type (Rigid,Flexible,NASTRAN)                       R
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz              .8543E12 1.5601E12
1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 69 BO   2 Mass (kg)                                           12666300
 70 BO   2 Number of Nodes                                     5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                 1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                 3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                 4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                 5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                      3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                       R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 93 BO   3 Mass (kg)                                           2046600
 94 BO   3 Number of Nodes                                     2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                 1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                      4
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                       R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
```

110	BO	4	Conversion factors: Length,Mass,Force	
111	BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112	BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113	BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114	BO	4	Mass (kg)	2046600
115	BO	4	Number of Nodes	2
116	BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117	BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118	BO	4	Node ID, Node structual joint ID	

HINGE

119	HI	1	Hinge ID number	1
120	HI	1	Inboard body ID, Outboard body ID	0 1
121	HI	1	"p" node ID, "q" node ID	0 2
122	HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123	HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124	HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125	HI	1	L2 unit vector in inboard body coord. x,y,z	
126	HI	1	L2 unit vector in outboard body coord. x,y,z	
127	HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128	HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129	HI	1	Initial rotation angles (deg)	-90 0 90
130	HI	1	Initial rotation rates (deg/sec)	0 0 0.00417807
131	HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132	HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133	HI	1	Null torque angles (deg)	0 0 0
134	HI	1	Number of translation DOFs	3
135	HI	1	First translation unit vector g1	1 0 0
136	HI	1	Second translation unit vector g2	0 1 0
137	HI	1	Third translation unit vector g3	0 0 1
138	HI	1	Initial translation (meters)	0 0 42163421
139	HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140	HI	1	Translation stiffness (newtons/meters)	0 0 0
141	HI	1	Translation damping (newtons/meter/sec)	0 0 0
142	HI	1	Null force translations	0 0 0
143	HI	2	Hinge ID number	2
144	HI	2	Inboard body ID, Outboard body ID	1 2
145	HI	2	"p" node ID, "q" node ID	2 2
146	HI	2	Number of rotation DOFs	0
147	HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148	HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149	HI	2	L2 unit vector in inboard body coord. x,y,z	
150	HI	2	L2 unit vector in outboard body coord. x,y,z	
151	HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152	HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153	HI	2	Initial rotation angles (deg)	0 0 0
154	HI	2	Initial rotation rates (deg/sec)	
155	HI	2	Rotation stiffness (newton-meters/rad)	
156	HI	2	Rotation damping (newton-meters/rad/sec)	
157	HI	2	Null torque angles (deg)	
158	HI	2	Number of translation DOFs	0
159	HI	2	First translation unit vector g1	1 0 0
160	HI	2	Second translation unit vector g2	0 1 0
161	HI	2	Third translation unit vector g3	0 0 1
162	HI	2	Initial translation (meters)	0 0 0
163	HI	2	Initial translation velocity (meters/sec)	
164	HI	2	Translation stiffness (newtons/meters)	
165	HI	2	Translation damping (newtons/meter/sec)	
166	HI	2	Null force translations	
167	HI	3	Hinge ID number	3
168	HI	3	Inboard body ID, Outboard body ID	1 3
169	HI	3	"p" node ID, "q" node ID	3 2
170	HI	3	Number of rotation DOFs	3
171	HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172	HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173	HI	3	L2 unit vector in inboard body coord. x,y,z	
174	HI	3	L2 unit vector in outboard body coord. x,y,z	

175	HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176	HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177	HI	3	Initial rotation angles (deg)	0. 0. -135.
178	HI	3	Initial rotation rates (deg/sec)	-0.004178 0 0
179	HI	3	Rotation stiffness (newton-meters/rad)	0 0 0
180	HI	3	Rotation damping (newton-meters/rad/sec)	0 0 0
181	HI	3	Null torque angles (deg)	0 0 0
182	HI	3	Number of translation DOFs	0
183	HI	3	First translation unit vector g1	1 0 0
184	HI	3	Second translation unit vector g2	0 1 0
185	HI	3	Third translation unit vector g3	0 0 1
186	HI	3	Initial translation (meters)	0 0 0
187	HI	3	Initial translation velocity (meters/sec)	
188	HI	3	Translation stiffness (newtons/meters)	
189	HI	3	Translation damping (newtons/meter/sec)	
190	HI	3	Null force translations	
191	HI	4	Hinge ID number	4
192	HI	4	Inboard body ID, Outboard body ID	1 4
193	HI	4	"p" node ID, "q" node ID	4 2
194	HI	4	Number of rotation DOFs	3
195	HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196	HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197	HI	4	L2 unit vector in inboard body coord. x,y,z	
198	HI	4	L2 unit vector in outboard body coord. x,y,z	
199	HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200	HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201	HI	4	Initial rotation angles (deg)	0. 0. -45.
202	HI	4	Initial rotation rates (deg/sec)	-0.004178 0 0
203	HI	4	Rotation stiffness (newton-meters/rad)	0 0 0
204	HI	4	Rotation damping (newton-meters/rad/sec)	0 0 0
205	HI	4	Null torque angles (deg)	0 0 0
206	HI	4	Number of translation DOFs	0
207	HI	4	First translation unit vector g1	1 0 0
208	HI	4	Second translation unit vector g2	0 1 0
209	HI	4	Third translation unit vector g3	0 0 1
210	HI	4	Initial translation (meters)	0 0 0
211	HI	4	Initial translation velocity (meters/sec)	
212	HI	4	Translation stiffness (newtons/meters)	
213	HI	4	Translation damping (newtons/meter/sec)	
214	HI	4	Null force translations	

SENSOR

215	SE	1	Sensor ID number	1
216	SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217	SE	1	Mounting point body ID, Mounting point node ID	2 2
218	SE	1	Second mounting point body ID, Second node ID	
219	SE	1	Input axis unit vector (IA) x,y,z	
220	SE	1	Mounting point Hinge index, Axis index	
221	SE	1	First focal plane unit vector (Fp1) x,y,z	0 0 -1
222	SE	1	Second focal plane unit vector (Fp2) x,y,z	0 1 0
223	SE	1	Sun/Star unit vector (Us) x,y,z	
224	SE	1	Velocity Aberration Option (Y/N)	
225	SE	1	Euler Angle Sequence (1-6)	
226	SE	1	CMG ID number and Gimbal number	
227	SE	1	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	6378000 0 0 4.178074D-3
228	SE	2	Sensor ID number	2
229	SE	2	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ST
230	SE	2	Mounting point body ID, Mounting point node ID	2 2
231	SE	2	Second mounting point body ID, Second node ID	
232	SE	2	Input axis unit vector (IA) x,y,z	
233	SE	2	Mounting point Hinge index, Axis index	
234	SE	2	First focal plane unit vector (Fp1) x,y,z	0 -1 0
235	SE	2	Second focal plane unit vector (Fp2) x,y,z	1 0 0
236	SE	2	Sun/Star unit vector (Us) x,y,z	0 1 0
237	SE	2	Velocity Aberration Option (Y/N)	N
238	SE	2	Euler Angle Sequence (1-6)	
239	SE	2	CMG ID number and Gimbal number	

```
240 SE   2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE   3 Sensor ID number                                          3
242 SE   3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)        L
243 SE   3 Mounting point body ID, Mounting point node ID            3 2
244 SE   3 Second mounting point body ID, Second node ID
245 SE   3 Input axis unit vector (IA) x,y,z                         1 2 3
246 SE   3 Mounting point Hinge index, Axis index
247 SE   3 First focal plane unit vector  (Fp1) x,y,z
248 SE   3 Second focal plane unit vector (Fp2) x,y,z
249 SE   3 Sun/Star unit vector (Us) x,y,z
250 SE   3 Velocity Aberration Option (Y/N)
251 SE   3 Euler Angle Sequence (1-6)
252 SE   3 CMG ID number and Gimbal number
253 SE   3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE   4 Sensor ID number                                          4
255 SE   4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)        L
256 SE   4 Mounting point body ID, Mounting point node ID            4 2
257 SE   4 Second mounting point body ID, Second node ID
258 SE   4 Input axis unit vector (IA) x,y,z                         3 2 1
259 SE   4 Mounting point Hinge index, Axis index
260 SE   4 First focal plane unit vector  (Fp1) x,y,z
261 SE   4 Second focal plane unit vector (Fp2) x,y,z
262 SE   4 Sun/Star unit vector (Us) x,y,z
263 SE   4 Velocity Aberration Option (Y/N)
264 SE   4 Euler Angle Sequence (1-6)
265 SE   4 CMG ID number and Gimbal number
266 SE   4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE   5 Sensor ID number                                          5
268 SE   5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)        ST
269 SE   5 Mounting point body ID, Mounting point node ID            2 5
270 SE   5 Second mounting point body ID, Second node ID
271 SE   5 Input axis unit vector (IA) x,y,z
272 SE   5 Mounting point Hinge index, Axis index
273 SE   5 First focal plane unit vector  (Fp1) x,y,z                0 0 1
274 SE   5 Second focal plane unit vector (Fp2) x,y,z                0 -1 0
275 SE   5 Sun/Star unit vector (Us) x,y,z                           0 0 0
276 SE   5 Velocity Aberration Option (Y/N)                          N
277 SE   5 Euler Angle Sequence (1-6)
278 SE   5 CMG ID number and Gimbal number
279 SE   5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE   6 Sensor ID number                                          6
281 SE   6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV        A3
282 SE   6 Mounting point body ID, Mounting point node ID            2 2
283 SE   6 Second mounting point body ID, Second node ID
284 SE   6 Input axis unit vector (IA) x,y,z
285 SE   6 Mounting point Hinge index, Axis index
286 SE   6 First focal plane unit vector  (Fp1) x,y,z
287 SE   6 Second focal plane unit vector (Fp2) x,y,z
288 SE   6 Sun/Star unit vector (Us) x,y,z
289 SE   6 Velocity Aberration Option (Y/N)
290 SE   6 Euler Angle Sequence (1-6)
291 SE   6 CMG ID number and Gimbal number
292 SE   6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE   7 Sensor ID number                                          7
294 SE   7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV        AC
295 SE   7 Mounting point body ID, Mounting point node ID            2 2
296 SE   7 Second mounting point body ID, Second node ID
297 SE   7 Input axis unit vector (IA) x,y,z                         1 0 0
298 SE   7 Mounting point Hinge index, Axis index
299 SE   7 First focal plane unit vector  (Fp1) x,y,z
300 SE   7 Second focal plane unit vector (Fp2) x,y,z
301 SE   7 Sun/Star unit vector (Us) x,y,z
302 SE   7 Velocity Aberration Option (Y/N)
303 SE   7 Euler Angle Sequence (1-6)
304 SE   7 CMG ID number and Gimbal number
305 SE   7 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])
```

ACTR

```
306 AC   1 Actuator ID number                                          1
307 AC   1 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                         MO
308 AC   1 Actuator location; Node or Hinge (N or H)
309 AC   1 Mounting point body ID number, node ID number               2 2
310 AC   1 Second mounting point body ID, second node ID
311 AC   1 Output axis unit vector x,y,z                               0 1 0
312 AC   1 Mounting point Hinge index, Axis index
313 AC   1 Rotor spin axis unit vector x,y,z
314 AC   1 Initial rotor momentum, H
315 AC   1 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
316 AC   1 Outer gimbal axis unit vector x,y,z
317 AC   1 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
318 AC   1 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
319 AC   1 Inner gimbal axis unit vector x,y,z
320 AC   1 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
321 AC   1 Initial length and rate, y(to) and ydot(to)
322 AC   1 Constants; K1 or wo, n or zeta, Kg, Jm
323 AC   1 Non-linearities; TLim, Tco, Dz

324 AC   2 Actuator ID number                                          2
325 AC   2 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                         MO
326 AC   2 Actuator location; Node or Hinge (N or H)
327 AC   2 Mounting point body ID number, node ID number               2 2
328 AC   2 Second mounting point body ID, second node ID
329 AC   2 Output axis unit vector x,y,z                               0 0 1
330 AC   2 Mounting point Hinge index, Axis index
331 AC   2 Rotor spin axis unit vector x,y,z
332 AC   2 Initial rotor momentum, H
333 AC   2 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
334 AC   2 Outer gimbal axis unit vector x,y,z
335 AC   2 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
336 AC   2 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
337 AC   2 Inner gimbal axis unit vector x,y,z
338 AC   2 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
339 AC   2 Initial length and rate, y(to) and ydot(to)
340 AC   2 Constants; K1 or wo, n or zeta, Kg, Jm
341 AC   2 Non-linearities; TLim, Tco, Dz

342 AC   3 Actuator ID number                                          3
343 AC   3 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                         MO
344 AC   3 Actuator location; Node or Hinge (N or H)
345 AC   3 Mounting point body ID number, node ID number               2 2
346 AC   3 Second mounting point body ID, second node ID
347 AC   3 Output axis unit vector x,y,z                               1 0 0
348 AC   3 Mounting point Hinge index, Axis index
349 AC   3 Rotor spin axis unit vector x,y,z
350 AC   3 Initial rotor momentum, H
351 AC   3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
352 AC   3 Outer gimbal axis unit vector x,y,z
353 AC   3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
354 AC   3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
355 AC   3 Inner gimbal axis unit vector x,y,z
356 AC   3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
357 AC   3 Initial length and rate, y(to) and ydot(to)
358 AC   3 Constants; K1 or wo, n or zeta, Kg, Jm
359 AC   3 Non-linearities; TLim, Tco, Dz

360 AC   4 Actuator ID number                                          4
361 AC   4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                         MO
362 AC   4 Actuator location; Node or Hinge (N or H)
363 AC   4 Mounting point body ID number, node ID number               3 2
364 AC   4 Second mounting point body ID, second node ID
365 AC   4 Output axis unit vector x,y,z                               1 0 0
366 AC   4 Mounting point Hinge index, Axis index
367 AC   4 Rotor spin axis unit vector x,y,z
368 AC   4 Initial rotor momentum, H
369 AC   4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
```

```
370 AC   4 Outer gimbal axis unit vector x,y,z
371 AC   4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
372 AC   4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
373 AC   4 Inner gimbal axis unit vector x,y,z
374 AC   4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
375 AC   4 Initial length and rate, y(to) and ydot(to)
376 AC   4 Constants; K1 or wo, n or zeta, Kg, Jm
377 AC   4 Non-linearities; TLim, Tco, Dz

378 AC   5 Actuator ID number                                  5
379 AC   5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
380 AC   5 Actuator location; Node or Hinge (N or H)
381 AC   5 Mounting point body ID number, node ID number       3 2
382 AC   5 Second mounting point body ID, second node ID
383 AC   5 Output axis unit vector x,y,z                       0 1 0
384 AC   5 Mounting point Hinge index, Axis index
385 AC   5 Rotor spin axis unit vector x,y,z
386 AC   5 Initial rotor momentum, H
387 AC   5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
388 AC   5 Outer gimbal axis unit vector x,y,z
389 AC   5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
390 AC   5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
391 AC   5 Inner gimbal axis unit vector x,y,z
392 AC   5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
393 AC   5 Initial length and rate, y(to) and ydot(to)
394 AC   5 Constants; K1 or wo, n or zeta, Kg, Jm
395 AC   5 Non-linearities; TLim, Tco, Dz

396 AC   6 Actuator ID number                                  6
397 AC   6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
398 AC   6 Actuator location; Node or Hinge (N or H)
399 AC   6 Mounting point body ID number, node ID number       3 2
400 AC   6 Second mounting point body ID, second node ID
401 AC   6 Output axis unit vector x,y,z                       0 0 1
402 AC   6 Mounting point Hinge index, Axis index
403 AC   6 Rotor spin axis unit vector x,y,z
404 AC   6 Initial rotor momentum, H
405 AC   6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
406 AC   6 Outer gimbal axis unit vector x,y,z
407 AC   6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
408 AC   6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
409 AC   6 Inner gimbal axis unit vector x,y,z
410 AC   6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
411 AC   6 Initial length and rate, y(to) and ydot(to)
412 AC   6 Constants; K1 or wo, n or zeta, Kg, Jm
413 AC   6 Non-linearities; TLim, Tco, Dz

414 AC   7 Actuator ID number                                  7
415 AC   7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
416 AC   7 Actuator location; Node or Hinge (N or H)
417 AC   7 Mounting point body ID number, node ID number       4 2
418 AC   7 Second mounting point body ID, second node ID
419 AC   7 Output axis unit vector x,y,z                       1 0 0
420 AC   7 Mounting point Hinge index, Axis index
421 AC   7 Rotor spin axis unit vector x,y,z
422 AC   7 Initial rotor momentum, H
423 AC   7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
424 AC   7 Outer gimbal axis unit vector x,y,z
425 AC   7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
426 AC   7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
427 AC   7 Inner gimbal axis unit vector x,y,z
428 AC   7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
429 AC   7 Initial length and rate, y(to) and ydot(to)
430 AC   7 Constants; K1 or wo, n or zeta, Kg, Jm
431 AC   7 Non-linearities; TLim, Tco, Dz

432 AC   8 Actuator ID number                                  8
433 AC   8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                 MO
434 AC   8 Actuator location; Node or Hinge (N or H)
435 AC   8 Mounting point body ID number, node ID number       4 2
436 AC   8 Second mounting point body ID, second node ID
```

```
437 AC   8 Output axis unit vector x,y,z                              0 1 0
438 AC   8 Mounting point Hinge index, Axis index
439 AC   8 Rotor spin axis unit vector x,y,z
440 AC   8 Initial rotor momentum, H
441 AC   8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
442 AC   8 Outer gimbal axis unit vector x,y,z
443 AC   8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
444 AC   8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
445 AC   8 Inner gimbal axis unit vector x,y,z
446 AC   8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
447 AC   8 Initial length and rate, y(to) and ydot(to)
448 AC   8 Constants; K1 or wo, n or zeta, Kg, Jm
449 AC   8 Non-linearities; TLim, Tco, Dz

450 AC   9 Actuator ID number                                         9
451 AC   9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)                      MO
452 AC   9 Actuator location; Node or Hinge (N or H)
453 AC   9 Mounting point body ID number, node ID number              4 2
454 AC   9 Second mounting point body ID, second node ID
455 AC   9 Output axis unit vector x,y,z                              0 0 1
456 AC   9 Mounting point Hinge index, Axis index
457 AC   9 Rotor spin axis unit vector x,y,z
458 AC   9 Initial rotor momentum, H
459 AC   9 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
460 AC   9 Outer gimbal axis unit vector x,y,z
461 AC   9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
462 AC   9 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
463 AC   9 Inner gimbal axis unit vector x,y,z
464 AC   9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
465 AC   9 Initial length and rate, y(to) and ydot(to)
466 AC   9 Constants; K1 or wo, n or zeta, Kg, Jm
467 AC   9 Non-linearities; TLim, Tco, Dz

468 AC  10 Actuator ID number                                         10
469 AC  10 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)                      J
470 AC  10 Actuator location; Node or Hinge (N or H)
471 AC  10 Mounting point body ID number, node ID number              2 5
472 AC  10 Second mounting point body ID, second node ID
473 AC  10 Output axis unit vector x,y,z                              -1 0 0
474 AC  10 Mounting point Hinge index, Axis index
475 AC  10 Rotor spin axis unit vector x,y,z
476 AC  10 Initial rotor momentum, H
477 AC  10 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
478 AC  10 Outer gimbal axis unit vector x,y,z
479 AC  10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
480 AC  10 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
481 AC  10 Inner gimbal axis unit vector x,y,z
482 AC  10 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
483 AC  10 Initial length and rate, y(to) and ydot(to)
484 AC  10 Constants; K1 or wo, n or zeta, Kg, Jm
485 AC  10 Non-linearities; TLim, Tco, Dz

        CONTROLLER

486 CO   1 Controller ID number                                       1
487 CO   1 Controller type (CB,CM,DB,DM,UC,UD)                        CM
488 CO   1 Sample time (sec)
489 CO   1 Number of inputs, Number of outputs                        9 9
490 CO   1 Number of states
491 CO   1 Output No., Input type (I,S,T), Input ID, Gain

        INTERCONNECT

492 IN   1 Interconnect ID number                                     1
493 IN   1 Source type(S,C, or F),Source ID,Source row #              S 1 1
494 IN   1 Destination type(A or C),Dest ID,Dest row #                C 1 1
495 IN   1 Gain                                                       4.41E13

496 IN   2 Interconnect ID number                                     2
```

```
497 IN   2 Source type(S,C, or F),Source ID,Source row #        C 1 1
498 IN   2 Destination type(A or C),Dest ID,Dest row #          A 1 1
499 IN   2 Gain                                                 1

500 IN   3 Interconnect ID number                               3
501 IN   3 Source type(S,C, or F),Source ID,Source row #        S 1 2
502 IN   3 Destination type(A or C),Dest ID,Dest row #          C 1 2
503 IN   3 Gain                                                 1.67E12

504 IN   4 Interconnect ID number                               4
505 IN   4 Source type(S,C, or F),Source ID,Source row #        C 1 2
506 IN   4 Destination type(A or C),Dest ID,Dest row #          A 2 1
507 IN   4 Gain                                                 1

508 IN   5 Interconnect ID number                               5
509 IN   5 Source type(S,C, or F),Source ID,Source row #        S 2 1
510 IN   5 Destination type(A or C),Dest ID,Dest row #          C 1 3
511 IN   5 Gain                                                 4.31E13

512 IN   6 Interconnect ID number                               6
513 IN   6 Source type(S,C, or F),Source ID,Source row #        C 1 3
514 IN   6 Destination type(A or C),Dest ID,Dest row #          A 3 1
515 IN   6 Gain                                                 1

516 IN   7 Interconnect ID number                               7
517 IN   7 Source type(S,C, or F),Source ID,Source row #        S 3 1
518 IN   7 Destination type(A or C),Dest ID,Dest row #          C 1 4
519 IN   7 Gain                                                 1.7E12

520 IN   8 Interconnect ID number                               8
521 IN   8 Source type(S,C, or F),Source ID,Source row #        C 1 4
522 IN   8 Destination type(A or C),Dest ID,Dest row #          A 4 1
523 IN   8 Gain                                                 1

524 IN   9 Interconnect ID number                               9
525 IN   9 Source type(S,C, or F),Source ID,Source row #        S 3 2
526 IN   9 Destination type(A or C),Dest ID,Dest row #          C 1 5
527 IN   9 Gain                                                 1.7E12

528 IN  10 Interconnect ID number                               10
529 IN  10 Source type(S,C, or F),Source ID,Source row #        C 1 5
530 IN  10 Destination type(A or C),Dest ID,Dest row #          A 5 1
531 IN  10 Gain                                                 1

532 IN  11 Interconnect ID number                               11
533 IN  11 Source type(S,C, or F),Source ID,Source row #        S 3 3
534 IN  11 Destination type(A or C),Dest ID,Dest row #          C 1 6
535 IN  11 Gain                                                 3.4E12

536 IN  12 Interconnect ID number                               12
537 IN  12 Source type(S,C, or F),Source ID,Source row #        C 1 6
538 IN  12 Destination type(A or C),Dest ID,Dest row #          A 6 1
539 IN  12 Gain                                                 1

540 IN  13 Interconnect ID number                               13
541 IN  13 Source type(S,C, or F),Source ID,Source row #        S 4 1
542 IN  13 Destination type(A or C),Dest ID,Dest row #          C 1 7
543 IN  13 Gain                                                 1.7E12

544 IN  14 Interconnect ID number                               14
545 IN  14 Source type(S,C, or F),Source ID,Source row #        C 1 7
546 IN  14 Destination type(A or C),Dest ID,Dest row #          A 7 1
547 IN  14 Gain                                                 1

548 IN  15 Interconnect ID number                               15
549 IN  15 Source type(S,C, or F),Source ID,Source row #        S 4 2
550 IN  15 Destination type(A or C),Dest ID,Dest row #          C 1 8
551 IN  15 Gain                                                 1.7E12

552 IN  16 Interconnect ID number                               16
553 IN  16 Source type(S,C, or F),Source ID,Source row #        C 1 8
```

```
554 IN  16 Destination type(A or C),Dest ID,Dest row #          A 8 1
555 IN  16 Gain                                                  1

556 IN  17 Interconnect ID number                                17
557 IN  17 Source type(S,C, or F),Source ID,Source row #         S 4 3
558 IN  17 Destination type(A or C),Dest ID,Dest row #           C 1 9
559 IN  17 Gain                                                  3.4E12

560 IN  18 Interconnect ID number                                18
561 IN  18 Source type(S,C, or F),Source ID,Source row #         C 1 9
562 IN  18 Destination type(A or C),Dest ID,Dest row #           A 9 1
563 IN  18 Gain                                                  1

564 IN  19 Interconnect ID number                                19
565 IN  19 Source type(S,C, or F),Source ID,Source row #         S 5 3
566 IN  19 Destination type(A or C),Dest ID,Dest row #           A 10 1
567 IN  19 Gain                                                  7
```

isc3_flex_autmeq.int (Concept 3) Autumnal Equinox

```
TREETOPS REV 10P2  4/10/00

          SIM CONTROL

 1 SI   0 Title                                                  ISC MODEL, THIRD VERSION
 2 SI   0 Simulation stop time                                   100000
 3 SI   0 Plot data interval                                     20
 4 SI   0 Integration type (R,S,U, OR V)                         R
 5 SI   0 Step size (sec)                                        .1
 6 SI   0 Sandia ODE solver absolute and relative error
 7 SI   0 RK78 ODE solver absolute error and first step size
 8 SI   0 Linearization option  (L,Z or N)                       N
 9 SI   0 Restart option          (Y/N)                          N
10 SI   0 Contact force computation option      (Y/N)            Y
11 SI   0 Constraint force computation option   (Y/N)            N
12 SI   0 Small angle speedup option (All,Bypass,First,Nth)       A
13 SI   0 Mass matrix speedup option (All,Bypass,First,Nth)       A
14 SI   0 Non-Linear  speedup option (All,Bypass,First,Nth)       A
15 SI   0 Constraint  speedup option (All,Bypass,First,Nth)       A
16 SI   0 Constraint stabilization option   (Y/N)                N
17 SI   0 Stabilization epsilon


          GENGRAV

18 GG   4 Gravity, earth sphere/nonsphere/user (S/N/U)?          N
19 GG   1 Input gravity constants:  GME, ERAD, EMASS
20 GG   1 Spherical or Nonspherical (S/N)?
21 GG   1 Gravity Potential Harmonics J2,J3,J4
22 GG   4 English (ft-slug-s) or metric (m-kg-s)    (E/M)?       M
23 GG   4 Day, Month, Year,                                      20 9 2020
24 GG   4 GMT @ sim time 0 (minutes past midnight,               360
25 GG   4 Solar Pressure forces Y/N?                             Y
26 GG   4 Input new data for aero model? (Y/N)                   N
27 GG   1   Solar flux F10 for aero model
28 GG   1   Solar flux, 81 day average F10B
29 GG   1   Geomagnetic index, GEAP


          BODY

30 BO   1 Body ID number                                         1
31 BO   1 Type (Rigid,Flexible,NASTRAN)                          F
32 BO   1 Number of modes                                        24
```

```
 33 BO   1 Modal calculation option (0, 1 or 2)                    2
 34 BO   1 Foreshortening option (Y/N)
 35 BO   1 Model reduction method (NO,MS,MC,CC,QM,CV)
 36 BO   1 NASTRAN data file FORTRAN unit number (40 - 60)
 37 BO   1 Number of augmented nodes (0 if none)
 38 BO   1 Damping matrix option (NS,CD,HL,SD)
 39 BO   1 Constant damping ratio
 40 BO   1 Low frequency, High frequency ratios
 41 BO   1 Mode ID number, damping ratio
 42 BO   1 Conversion factors: Length,Mass,Force
 43 BO   1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 44 BO   1 Moments of inertia (kg-m2) Ixx,Iyy,Izz                 6.2852173E11 6.2852173E11
6.7057352E8
 45 BO   1 Products of inertia (kg-m2) Ixy,Ixz,Iyz                 0 0 0
 46 BO   1 Mass (kg)                                               1.6168633E5
 47 BO   1 Number of Nodes                                         4
 48 BO   1 Node ID, Node coord. (meters) x,y,z                     1 0 0 0
 49 BO   1 Node ID, Node coord. (meters) x,y,z                     2 0 0 0
 50 BO   1 Node ID, Node coord. (meters) x,y,z                     3 0 0 3188.8
 51 BO   1 Node ID, Node coord. (meters) x,y,z                     4 0 0 -3188.8
 52 BO   1 Node ID, Node structual joint ID

 53 BO   2 Body ID number                                          2
 54 BO   2 Type (Rigid,Flexible,NASTRAN)                           R
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz                 .8543E12 1.5601E12
 1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz                 0 0 0
 69 BO   2 Mass (kg)                                               12666300
 70 BO   2 Number of Nodes                                         5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                     1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                     2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                     3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                     4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                     5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                          3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                           R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
 89 BO   3 Conversion factors: Length,Mass,Force
 90 BO   3 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 91 BO   3 Moments of inertia (kg-m2) Ixx,Iyy,Izz                 1.7E12 1.7E12 3.4E12
 92 BO   3 Products of inertia (kg-m2) Ixy,Ixz,Iyz                 0 0 0
 93 BO   3 Mass (kg)                                               2046600
 94 BO   3 Number of Nodes                                         2
 95 BO   3 Node ID, Node coord. (meters) x,y,z                     1 0 0 0
 96 BO   3 Node ID, Node coord. (meters) x,y,z                     2 0 0 0
 97 BO   3 Node ID, Node structual joint ID

 98 BO   4 Body ID number                                          4
```

```
 99 BO   4 Type (Rigid,Flexible,NASTRAN)                                R
100 BO   4 Number of modes
101 BO   4 Modal calculation option (0, 1 or 2)
102 BO   4 Foreshortening option (Y/N)
103 BO   4 Model reduction method (NO,MS,MC,CC,QM,CV)
104 BO   4 NASTRAN data file FORTRAN unit number (40 - 60)
105 BO   4 Number of augmented nodes (0 if none)
106 BO   4 Damping matrix option (NS,CD,HL,SD)
107 BO   4 Constant damping ratio
108 BO   4 Low frequency, High frequency ratios
109 BO   4 Mode ID number, damping ratio
110 BO   4 Conversion factors: Length,Mass,Force
111 BO   4 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
112 BO   4 Moments of inertia (kg-m2) Ixx,Iyy,Izz              1.7E12 1.7E12 3.4E12
113 BO   4 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
114 BO   4 Mass (kg)                                           2046600
115 BO   4 Number of Nodes                                     2
116 BO   4 Node ID, Node coord. (meters) x,y,z                 1 0 0 0
117 BO   4 Node ID, Node coord. (meters) x,y,z                 2 0 0 0
118 BO   4 Node ID, Node structual joint ID

           HINGE

119 HI   1 Hinge ID number                                     1
120 HI   1 Inboard body ID, Outboard body ID                   0 1
121 HI   1 "p" node ID, "q" node ID                            0 2
122 HI   1 Number of rotation DOFs, Rotation option (F or G)   3 F
123 HI   1 L1 unit vector in inboard body coord. x,y,z         1 0 0
124 HI   1 L1 unit vector in outboard body coord. x,y,z        1 0 0
125 HI   1 L2 unit vector in inboard body coord. x,y,z
126 HI   1 L2 unit vector in outboard body coord. x,y,z
127 HI   1 L3 unit vector in inboard body coord. x,y,z         0 0 1
128 HI   1 L3 unit vector in outboard body coord. x,y,z        0 0 1
129 HI   1 Initial rotation angles (deg)                       -90 0 90
130 HI   1 Initial rotation rates (deg/sec)                    0 0 0.00417807
131 HI   1 Rotation stiffness (newton-meters/rad)              0 0 0
132 HI   1 Rotation damping (newton-meters/rad/sec)            0 0 0
133 HI   1 Null torque angles (deg)                            0 0 0
134 HI   1 Number of translation DOFs                          3
135 HI   1 First translation unit vector   g1                  1 0 0
136 HI   1 Second translation unit vector  g2                  0 1 0
137 HI   1 Third translation unit vector   g3                  0 0 1
138 HI   1 Initial translation (meters)                        0 0 42163421
139 HI   1 Initial translation velocity (meters/sec)           3074.681 0 0
140 HI   1 Translation stiffness (newtons/meters)              0 0 0
141 HI   1 Translation damping (newtons/meter/sec)             0 0 0
142 HI   1 Null force translations                             0 0 0

143 HI   2 Hinge ID number                                     2
144 HI   2 Inboard body ID, Outboard body ID                   1 2
145 HI   2 "p" node ID, "q" node ID                            2 2
146 HI   2  Number of rotation DOFs                            0
147 HI   2 L1 unit vector in inboard body coord. x,y,z         0 0 1
148 HI   2 L1 unit vector in outboard body coord. x,y,z        0 0 1
149 HI   2 L2 unit vector in inboard body coord. x,y,z
150 HI   2 L2 unit vector in outboard body coord. x,y,z
151 HI   2 L3 unit vector in inboard body coord. x,y,z         1 0 0
152 HI   2 L3 unit vector in outboard body coord. x,y,z        1 0 0
153 HI   2 Initial rotation angles (deg)                       0 0 0
154 HI   2 Initial rotation rates (deg/sec)
155 HI   2 Rotation stiffness (newton-meters/rad)
156 HI   2 Rotation damping (newton-meters/rad/sec)
157 HI   2 Null torque angles (deg)
158 HI   2 Number of translation DOFs                          0
159 HI   2 First translation unit vector   g1                  1 0 0
160 HI   2 Second translation unit vector  g2                  0 1 0
161 HI   2 Third translation unit vector   g3                  0 0 1
162 HI   2 Initial translation (meters)                        0 0 0
163 HI   2 Initial translation velocity (meters/sec)
164 HI   2 Translation stiffness (newtons/meters)
```

```
165 HI   2 Translation damping (newtons/meter/sec)
166 HI   2 Null force translations
                                                                   3
167 HI   3 Hinge ID number                                         1 3
168 HI   3 Inboard body ID, Outboard body ID                       3 2
169 HI   3 "p" node ID, "q" node ID                                3
170 HI   3  Number of rotation DOFs                                0 0 1
171 HI   3 L1 unit vector in inboard body coord. x,y,z             0 0 1
172 HI   3 L1 unit vector in outboard body coord. x,y,z
173 HI   3 L2 unit vector in inboard body coord. x,y,z
174 HI   3 L2 unit vector in outboard body coord. x,y,z            0 1 0
175 HI   3 L3 unit vector in inboard body coord. x,y,z             0 1 0
176 HI   3 L3 unit vector in outboard body coord. x,y,z            180. 0 -135.
177 HI   3 Initial rotation angles (deg)                           -0.004178 0 0
178 HI   3 Initial rotation rates (deg/sec)                        0 0 0
179 HI   3 Rotation stiffness (newton-meters/rad)                  0 0 0
180 HI   3 Rotation damping (newton-meters/rad/sec)                0 0 0
181 HI   3 Null torque angles (deg)                                0
182 HI   3 Number of translation DOFs                              1 0 0
183 HI   3 First translation unit vector    g1                     0 1 0
184 HI   3 Second translation unit vector   g2                     0 0 1
185 HI   3 Third translation unit vector    g3                     0 0 0
186 HI   3 Initial translation (meters)
187 HI   3 Initial translation velocity (meters/sec)
188 HI   3 Translation stiffness (newtons/meters)
189 HI   3 Translation damping (newtons/meter/sec)
190 HI   3 Null force translations
                                                                   4
191 HI   4 Hinge ID number                                         1 4
192 HI   4 Inboard body ID, Outboard body ID                       4 2
193 HI   4 "p" node ID, "q" node ID                                3
194 HI   4  Number of rotation DOFs                                0 0 1
195 HI   4 L1 unit vector in inboard body coord. x,y,z             0 0 1
196 HI   4 L1 unit vector in outboard body coord. x,y,z
197 HI   4 L2 unit vector in inboard body coord. x,y,z
198 HI   4 L2 unit vector in outboard body coord. x,y,z            0 1 0
199 HI   4 L3 unit vector in inboard body coord. x,y,z             0 1 0
200 HI   4 L3 unit vector in outboard body coord. x,y,z            180. 0 -45.
201 HI   4 Initial rotation angles (deg)                           -0.004178 0 0
202 HI   4 Initial rotation rates (deg/sec)                        0 0 0
203 HI   4 Rotation stiffness (newton-meters/rad)                  0 0 0
204 HI   4 Rotation damping (newton-meters/rad/sec)                0 0 0
205 HI   4 Null torque angles (deg)                                0
206 HI   4 Number of translation DOFs                              1 0 0
207 HI   4 First translation unit vector    g1                     0 1 0
208 HI   4 Second translation unit vector   g2                     0 0 1
209 HI   4 Third translation unit vector    g3                     0 0 0
210 HI   4 Initial translation (meters)
211 HI   4 Initial translation velocity (meters/sec)
212 HI   4 Translation stiffness (newtons/meters)
213 HI   4 Translation damping (newtons/meter/sec)
214 HI   4 Null force translations

           SENSOR

                                                                   1
215 SE   1 Sensor ID number
216 SE   1 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)      ET
217 SE   1 Mounting point body ID, Mounting point node ID          2 2
218 SE   1 Second mounting point body ID, Second node ID
219 SE   1 Input axis unit vector (IA) x,y,z
220 SE   1 Mounting point Hinge index, Axis index                  0 0 -1
221 SE   1 First focal plane unit vector  (Fp1) x,y,z              0 1 0
222 SE   1 Second focal plane unit vector (Fp2) x,y,z
223 SE   1 Sun/Star unit vector (Us) x,y,z
224 SE   1 Velocity Aberration Option (Y/N)
225 SE   1 Euler Angle Sequence (1-6)
226 SE   1 CMG ID number and Gimbal number                         6378000 0 0 4.178074D-3
227 SE   1 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])
                                                                   2
228 SE   2 Sensor ID number
```

```
229 SE   2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)  ST
230 SE   2 Mounting point body ID, Mounting point node ID     2 2
231 SE   2 Second mounting point body ID, Second node ID
232 SE   2 Input axis unit vector (IA) x,y,z
233 SE   2 Mounting point Hinge index, Axis index
234 SE   2 First focal plane unit vector  (Fp1) x,y,z         0 -1 0
235 SE   2 Second focal plane unit vector (Fp2) x,y,z         1 0 0
236 SE   2 Sun/Star unit vector (Us) x,y,z                    0 1 0
237 SE   2 Velocity Aberration Option (Y/N)                   N
238 SE   2 Euler Angle Sequence (1-6)
239 SE   2 CMG ID number and Gimbal number
240 SE   2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE   3 Sensor ID number                                   3
242 SE   3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)  L
243 SE   3 Mounting point body ID, Mounting point node ID     3 2
244 SE   3 Second mounting point body ID, Second node ID
245 SE   3 Input axis unit vector (IA) x,y,z                  1 2 3
246 SE   3 Mounting point Hinge index, Axis index
247 SE   3 First focal plane unit vector  (Fp1) x,y,z
248 SE   3 Second focal plane unit vector (Fp2) x,y,z
249 SE   3 Sun/Star unit vector (Us) x,y,z
250 SE   3 Velocity Aberration Option (Y/N)
251 SE   3 Euler Angle Sequence (1-6)
252 SE   3 CMG ID number and Gimbal number
253 SE   3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE   4 Sensor ID number                                   4
255 SE   4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)  L
256 SE   4 Mounting point body ID, Mounting point node ID     4 2
257 SE   4 Second mounting point body ID, Second node ID
258 SE   4 Input axis unit vector (IA) x,y,z                  3 2 1
259 SE   4 Mounting point Hinge index, Axis index
260 SE   4 First focal plane unit vector  (Fp1) x,y,z
261 SE   4 Second focal plane unit vector (Fp2) x,y,z
262 SE   4 Sun/Star unit vector (Us) x,y,z
263 SE   4 Velocity Aberration Option (Y/N)
264 SE   4 Euler Angle Sequence (1-6)
265 SE   4 CMG ID number and Gimbal number
266 SE   4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE   5 Sensor ID number                                   5
268 SE   5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)  ST
269 SE   5 Mounting point body ID, Mounting point node ID     2 5
270 SE   5 Second mounting point body ID, Second node ID
271 SE   5 Input axis unit vector (IA) x,y,z
272 SE   5 Mounting point Hinge index, Axis index
273 SE   5 First focal plane unit vector  (Fp1) x,y,z         0 0 1
274 SE   5 Second focal plane unit vector (Fp2) x,y,z         0 -1 0
275 SE   5 Sun/Star unit vector (Us) x,y,z                    0 0 0
276 SE   5 Velocity Aberration Option (Y/N)                   N
277 SE   5 Euler Angle Sequence (1-6)
278 SE   5 CMG ID number and Gimbal number
279 SE   5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE   6 Sensor ID number                                   6
281 SE   6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV A3
282 SE   6 Mounting point body ID, Mounting point node ID     2 2
283 SE   6 Second mounting point body ID, Second node ID
284 SE   6 Input axis unit vector (IA) x,y,z
285 SE   6 Mounting point Hinge index, Axis index
286 SE   6 First focal plane unit vector  (Fp1) x,y,z
287 SE   6 Second focal plane unit vector (Fp2) x,y,z
288 SE   6 Sun/Star unit vector (Us) x,y,z
289 SE   6 Velocity Aberration Option (Y/N)
290 SE   6 Euler Angle Sequence (1-6)
291 SE   6 CMG ID number and Gimbal number
292 SE   6 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

293 SE   7 Sensor ID number                                   7
294 SE   7 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV AC
```

295	SE	7	Mounting point body ID, Mounting point node ID	2 2
296	SE	7	Second mounting point body ID, Second node ID	
297	SE	7	Input axis unit vector (IA) x,y,z	1 0 0
298	SE	7	Mounting point Hinge index, Axis index	
299	SE	7	First focal plane unit vector (Fp1) x,y,z	
300	SE	7	Second focal plane unit vector (Fp2) x,y,z	
301	SE	7	Sun/Star unit vector (Us) x,y,z	
302	SE	7	Velocity Aberration Option (Y/N)	
303	SE	7	Euler Angle Sequence (1-6)	
304	SE	7	CMG ID number and Gimbal number	
305	SE	7	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	

ACTR

306	AC	1	Actuator ID number	1
307	AC	1	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308	AC	1	Actuator location; Node or Hinge (N or H)	
309	AC	1	Mounting point body ID number, node ID number	2 2
310	AC	1	Second mounting point body ID, second node ID	
311	AC	1	Output axis unit vector x,y,z	0 1 0
312	AC	1	Mounting point Hinge index, Axis index	
313	AC	1	Rotor spin axis unit vector x,y,z	
314	AC	1	Initial rotor momentum, H	
315	AC	1	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
316	AC	1	Outer gimbal axis unit vector x,y,z	
317	AC	1	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318	AC	1	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
319	AC	1	Inner gimbal axis unit vector x,y,z	
320	AC	1	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321	AC	1	Initial length and rate, y(to) and ydot(to)	
322	AC	1	Constants; K1 or wo, n or zeta, Kg, Jm	
323	AC	1	Non-linearities; TLim, Tco, Dz	
324	AC	2	Actuator ID number	2
325	AC	2	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326	AC	2	Actuator location; Node or Hinge (N or H)	
327	AC	2	Mounting point body ID number, node ID number	2 2
328	AC	2	Second mounting point body ID, second node ID	
329	AC	2	Output axis unit vector x,y,z	0 0 1
330	AC	2	Mounting point Hinge index, Axis index	
331	AC	2	Rotor spin axis unit vector x,y,z	
332	AC	2	Initial rotor momentum, H	
333	AC	2	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334	AC	2	Outer gimbal axis unit vector x,y,z	
335	AC	2	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336	AC	2	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337	AC	2	Inner gimbal axis unit vector x,y,z	
338	AC	2	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339	AC	2	Initial length and rate, y(to) and ydot(to)	
340	AC	2	Constants; K1 or wo, n or zeta, Kg, Jm	
341	AC	2	Non-linearities; TLim, Tco, Dz	
342	AC	3	Actuator ID number	3
343	AC	3	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344	AC	3	Actuator location; Node or Hinge (N or H)	
345	AC	3	Mounting point body ID number, node ID number	2 2
346	AC	3	Second mounting point body ID, second node ID	
347	AC	3	Output axis unit vector x,y,z	1 0 0
348	AC	3	Mounting point Hinge index, Axis index	
349	AC	3	Rotor spin axis unit vector x,y,z	
350	AC	3	Initial rotor momentum, H	
351	AC	3	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
352	AC	3	Outer gimbal axis unit vector x,y,z	
353	AC	3	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
354	AC	3	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
355	AC	3	Inner gimbal axis unit vector x,y,z	
356	AC	3	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
357	AC	3	Initial length and rate, y(to) and ydot(to)	
358	AC	3	Constants; K1 or wo, n or zeta, Kg, Jm	
359	AC	3	Non-linearities; TLim, Tco, Dz	

```
360 AC   4 Actuator ID number                                      4
361 AC   4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                     MO
362 AC   4 Actuator location; Node or Hinge (N or H)
363 AC   4 Mounting point body ID number, node ID number           3 2
364 AC   4 Second mounting point body ID, second node ID
365 AC   4 Output axis unit vector x,y,z                           1 0 0
366 AC   4 Mounting point Hinge index, Axis index
367 AC   4 Rotor spin axis unit vector x,y,z
368 AC   4 Initial rotor momentum, H
369 AC   4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
370 AC   4 Outer gimbal axis unit vector x,y,z
371 AC   4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
372 AC   4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
373 AC   4 Inner gimbal axis unit vector x,y,z
374 AC   4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
375 AC   4 Initial length and rate, y(to) and ydot(to)
376 AC   4 Constants; K1 or wo, n or zeta, Kg, Jm
377 AC   4 Non-linearities; TLim, Tco, Dz

378 AC   5 Actuator ID number                                      5
379 AC   5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                     MO
380 AC   5 Actuator location; Node or Hinge (N or H)
381 AC   5 Mounting point body ID number, node ID number           3 2
382 AC   5 Second mounting point body ID, second node ID
383 AC   5 Output axis unit vector x,y,z                           0 1 0
384 AC   5 Mounting point Hinge index, Axis index
385 AC   5 Rotor spin axis unit vector x,y,z
386 AC   5 Initial rotor momentum, H
387 AC   5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
388 AC   5 Outer gimbal axis unit vector x,y,z
389 AC   5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
390 AC   5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
391 AC   5 Inner gimbal axis unit vector x,y,z
392 AC   5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
393 AC   5 Initial length and rate, y(to) and ydot(to)
394 AC   5 Constants; K1 or wo, n or zeta, Kg, Jm
395 AC   5 Non-linearities; TLim, Tco, Dz

396 AC   6 Actuator ID number                                      6
397 AC   6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                     MO
398 AC   6 Actuator location; Node or Hinge (N or H)
399 AC   6 Mounting point body ID number, node ID number           3 2
400 AC   6 Second mounting point body ID, second node ID
401 AC   6 Output axis unit vector x,y,z                           0 0 1
402 AC   6 Mounting point Hinge index, Axis index
403 AC   6 Rotor spin axis unit vector x,y,z
404 AC   6 Initial rotor momentum, H
405 AC   6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
406 AC   6 Outer gimbal axis unit vector x,y,z
407 AC   6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
408 AC   6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
409 AC   6 Inner gimbal axis unit vector x,y,z
410 AC   6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
411 AC   6 Initial length and rate, y(to) and ydot(to)
412 AC   6 Constants; K1 or wo, n or zeta, Kg, Jm
413 AC   6 Non-linearities; TLim, Tco, Dz

414 AC   7 Actuator ID number                                      7
415 AC   7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                     MO
416 AC   7 Actuator location; Node or Hinge (N or H)
417 AC   7 Mounting point body ID number, node ID number           4 2
418 AC   7 Second mounting point body ID, second node ID
419 AC   7 Output axis unit vector x,y,z                           1 0 0
420 AC   7 Mounting point Hinge index, Axis index
421 AC   7 Rotor spin axis unit vector x,y,z
422 AC   7 Initial rotor momentum, H
423 AC   7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
424 AC   7 Outer gimbal axis unit vector x,y,z
425 AC   7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
426 AC   7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
```

```
427 AC   7 Inner gimbal axis unit vector x,y,z
428 AC   7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
429 AC   7 Initial length and rate, y(to) and ydot(to)
430 AC   7 Constants; K1 or wo, n or zeta, Kg, Jm
431 AC   7 Non-linearities; TLim, Tco, Dz

432 AC   8 Actuator ID number                                    8
433 AC   8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                   MO
434 AC   8 Actuator location; Node or Hinge (N or H)
435 AC   8 Mounting point body ID number, node ID number         4 2
436 AC   8 Second mounting point body ID, second node ID
437 AC   8 Output axis unit vector x,y,z                         0 1 0
438 AC   8 Mounting point Hinge index, Axis index
439 AC   8 Rotor spin axis unit vector x,y,z
440 AC   8 Initial rotor momentum, H
441 AC   8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
442 AC   8 Outer gimbal axis unit vector x,y,z
443 AC   8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
444 AC   8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
445 AC   8 Inner gimbal axis unit vector x,y,z
446 AC   8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
447 AC   8 Initial length and rate, y(to) and ydot(to)
448 AC   8 Constants; K1 or wo, n or zeta, Kg, Jm
449 AC   8 Non-linearities; TLim, Tco, Dz

450 AC   9 Actuator ID number                                    9
451 AC   9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)                MO
452 AC   9 Actuator location; Node or Hinge (N or H)
453 AC   9 Mounting point body ID number, node ID number         4 2
454 AC   9 Second mounting point body ID, second node ID
455 AC   9 Output axis unit vector x,y,z                         0 0 1
456 AC   9 Mounting point Hinge index, Axis index
457 AC   9 Rotor spin axis unit vector x,y,z
458 AC   9 Initial rotor momentum, H
459 AC   9 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
460 AC   9 Outer gimbal axis unit vector x,y,z
461 AC   9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
462 AC   9 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
463 AC   9 Inner gimbal axis unit vector x,y,z
464 AC   9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
465 AC   9 Initial length and rate, y(to) and ydot(to)
466 AC   9 Constants; K1 or wo, n or zeta, Kg, Jm
467 AC   9 Non-linearities; TLim, Tco, Dz

468 AC  10 Actuator ID number                                    10
469 AC  10 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)                J
470 AC  10 Actuator location; Node or Hinge (N or H)
471 AC  10 Mounting point body ID number, node ID number         2 5
472 AC  10 Second mounting point body ID, second node ID
473 AC  10 Output axis unit vector x,y,z                         -1 0 0
474 AC  10 Mounting point Hinge index, Axis index
475 AC  10 Rotor spin axis unit vector x,y,z
476 AC  10 Initial rotor momentum, H
477 AC  10 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
478 AC  10 Outer gimbal axis unit vector x,y,z
479 AC  10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
480 AC  10 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
481 AC  10 Inner gimbal axis unit vector x,y,z
482 AC  10 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
483 AC  10 Initial length and rate, y(to) and ydot(to)
484 AC  10 Constants; K1 or wo, n or zeta, Kg, Jm
485 AC  10 Non-linearities; TLim, Tco, Dz

        CONTROLLER

486 CO   1 Controller ID number                                  1
487 CO   1 Controller type (CB,CM,DB,DM,UC,UD)                   CM
488 CO   1 Sample time (sec)
489 CO   1 Number of inputs, Number of outputs                   9 9
490 CO   1 Number of states
```

```
491 CO    1 Output No., Input type (I,S,T), Input ID, Gain

          INTERCONNECT

492 IN    1 Interconnect ID number                                  1
493 IN    1 Source type(S,C, or F),Source ID,Source row #           S 1 1
494 IN    1 Destination type(A or C),Dest ID,Dest row #             C 1 1
495 IN    1 Gain                                                    4.41E13

496 IN    2 Interconnect ID number                                  2
497 IN    2 Source type(S,C, or F),Source ID,Source row #           C 1 1
498 IN    2 Destination type(A or C),Dest ID,Dest row #             A 1 1
499 IN    2 Gain                                                    1

500 IN    3 Interconnect ID number                                  3
501 IN    3 Source type(S,C, or F),Source ID,Source row #           S 1 2
502 IN    3 Destination type(A or C),Dest ID,Dest row #             C 1 2
503 IN    3 Gain                                                    1.67E12

504 IN    4 Interconnect ID number                                  4
505 IN    4 Source type(S,C, or F),Source ID,Source row #           C 1 2
506 IN    4 Destination type(A or C),Dest ID,Dest row #             A 2 1
507 IN    4 Gain                                                    1

508 IN    5 Interconnect ID number                                  5
509 IN    5 Source type(S,C, or F),Source ID,Source row #           S 2 1
510 IN    5 Destination type(A or C),Dest ID,Dest row #             C 1 3
511 IN    5 Gain                                                    4.31E13

512 IN    6 Interconnect ID number                                  6
513 IN    6 Source type(S,C, or F),Source ID,Source row #           C 1 3
514 IN    6 Destination type(A or C),Dest ID,Dest row #             A 3 1
515 IN    6 Gain                                                    1

516 IN    7 Interconnect ID number                                  7
517 IN    7 Source type(S,C, or F),Source ID,Source row #           S 3 1
518 IN    7 Destination type(A or C),Dest ID,Dest row #             C 1 4
519 IN    7 Gain                                                    1.7E12

520 IN    8 Interconnect ID number                                  8
521 IN    8 Source type(S,C, or F),Source ID,Source row #           C 1 4
522 IN    8 Destination type(A or C),Dest ID,Dest row #             A 4 1
523 IN    8 Gain                                                    1

524 IN    9 Interconnect ID number                                  9
525 IN    9 Source type(S,C, or F),Source ID,Source row #           S 3 2
526 IN    9 Destination type(A or C),Dest ID,Dest row #             C 1 5
527 IN    9 Gain                                                    1.7E12

528 IN   10 Interconnect ID number                                  10
529 IN   10 Source type(S,C, or F),Source ID,Source row #           C 1 5
530 IN   10 Destination type(A or C),Dest ID,Dest row #             A 5 1
531 IN   10 Gain                                                    1

532 IN   11 Interconnect ID number                                  11
533 IN   11 Source type(S,C, or F),Source ID,Source row #           S 3 3
534 IN   11 Destination type(A or C),Dest ID,Dest row #             C 1 6
535 IN   11 Gain                                                    3.4E12

536 IN   12 Interconnect ID number                                  12
537 IN   12 Source type(S,C, or F),Source ID,Source row #           C 1 6
538 IN   12 Destination type(A or C),Dest ID,Dest row #             A 6 1
539 IN   12 Gain                                                    1

540 IN   13 Interconnect ID number                                  13
541 IN   13 Source type(S,C, or F),Source ID,Source row #           S 4 1
542 IN   13 Destination type(A or C),Dest ID,Dest row #             C 1 7
543 IN   13 Gain                                                    1.7E12

544 IN   14 Interconnect ID number                                  14
```

```
545 IN  14 Source type(S,C, or F),Source ID,Source row #      C 1 7
546 IN  14 Destination type(A or C),Dest ID,Dest row #        A 7 1
547 IN  14 Gain                                               1

548 IN  15 Interconnect ID number                             15
549 IN  15 Source type(S,C, or F),Source ID,Source row #      S 4 2
550 IN  15 Destination type(A or C),Dest ID,Dest row #        C 1 8
551 IN  15 Gain                                               1.7E12

552 IN  16 Interconnect ID number                             16
553 IN  16 Source type(S,C, or F),Source ID,Source row #      C 1 8
554 IN  16 Destination type(A or C),Dest ID,Dest row #        A 8 1
555 IN  16 Gain                                               1

556 IN  17 Interconnect ID number                             17
557 IN  17 Source type(S,C, or F),Source ID,Source row #      S 4 3
558 IN  17 Destination type(A or C),Dest ID,Dest row #        C 1 9
559 IN  17 Gain                                               3.4E12

560 IN  18 Interconnect ID number                             18
561 IN  18 Source type(S,C, or F),Source ID,Source row #      C 1 9
562 IN  18 Destination type(A or C),Dest ID,Dest row #        A 9 1
563 IN  18 Gain                                               1

564 IN  19 Interconnect ID number                             19
565 IN  19 Source type(S,C, or F),Source ID,Source row #      S 5 3
566 IN  19 Destination type(A or C),Dest ID,Dest row #        A 10 1
567 IN  19 Gain                                               7
```

isc3_flex_winsol.int (Concept 3) Winter Solstice

```
TREETOPS REV 10P2  4/10/00

           SIM CONTROL

 1 SI   0 Title                                                  ISC MODEL, THIRD VERSION
 2 SI   0 Simulation stop time                                   100000
 3 SI   0 Plot data interval                                     20
 4 SI   0 Integration type  (R,S,U, OR V)                        R
 5 SI   0 Step size (sec)                                        .1
 6 SI   0 Sandia ODE solver absolute and relative error
 7 SI   0 RK78 ODE solver absolute error and first step size
 8 SI   0 Linearization option  (L,Z or N)                       N
 9 SI   0 Restart option           (Y/N)                         N
10 SI   0 Contact force computation option      (Y/N)            Y
11 SI   0 Constraint force computation option   (Y/N)            N
12 SI   0 Small angle speedup option (All,Bypass,First,Nth)      A
13 SI   0 Mass matrix speedup option (All,Bypass,First,Nth)      A
14 SI   0 Non-Linear  speedup option (All,Bypass,First,Nth)      A
15 SI   0 Constraint  speedup option (All,Bypass,First,Nth)      A
16 SI   0 Constraint stabilization option   (Y/N)                N
17 SI   0 Stabilization epsilon

           GENGRAV

18 GG   0 Gravity, earth sphere/nonsphere/user (S/N/U)?          N
19 GG   1 Input gravity constants:  GME, ERAD, EMASS
20 GG   1 Spherical or Nonspherical (S/N)?
21 GG   1 Gravity Potential Harmonics J2,J3,J4
22 GG   0 English (ft-slug-s) or metric (m-kg-s)     (E/M)?      M
23 GG   0 Day, Month, Year,                                      20 12 2020
24 GG   0 GMT @ sim time 0 (minutes past midnight,               360
25 GG   0 Solar Pressure forces Y/N?                             Y
26 GG   0 Input new data for aero model? (Y/N)                   N
```

```
 27 GG   1   Solar flux F10 for aero model
 28 GG   1   Solar flux, 81 day average F10B
 29 GG   1   Geomagnetic index, GEAP

            BODY

 30 BO   1 Body ID number                                        1
 31 BO   1 Type (Rigid,Flexible,NASTRAN)                         F
 32 BO   1 Number of modes                                       24
 33 BO   1 Modal calculation option (0, 1 or 2)                  2
 34 BO   1 Foreshortening option (Y/N)
 35 BO   1 Model reduction method (NO,MS,MC,CC,QM,CV)
 36 BO   1 NASTRAN data file FORTRAN unit number (40 - 60)
 37 BO   1 Number of augmented nodes (0 if none)
 38 BO   1 Damping matrix option (NS,CD,HL,SD)
 39 BO   1 Constant damping ratio
 40 BO   1 Low frequency, High frequency ratios
 41 BO   1 Mode ID number, damping ratio
 42 BO   1 Conversion factors: Length,Mass,Force
 43 BO   1 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 44 BO   1 Moments of inertia (kg-m2) Ixx,Iyy,Izz              6.2852173E11 6.2852173E11
6.7057352E8
 45 BO   1 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 46 BO   1 Mass (kg)                                            1.6168633E5
 47 BO   1 Number of Nodes                                      4
 48 BO   1 Node ID, Node coord. (meters) x,y,z                  1 0 0 0
 49 BO   1 Node ID, Node coord. (meters) x,y,z                  2 0 0 0
 50 BO   1 Node ID, Node coord. (meters) x,y,z                  3 0 0 3188.8
 51 BO   1 Node ID, Node coord. (meters) x,y,z                  4 0 0 -3188.8
 52 BO   1 Node ID, Node structual joint ID

 53 BO   2 Body ID number                                       2
 54 BO   2 Type (Rigid,Flexible,NASTRAN)                        R
 55 BO   2 Number of modes
 56 BO   2 Modal calculation option (0, 1 or 2)
 57 BO   2 Foreshortening option (Y/N)
 58 BO   2 Model reduction method (NO,MS,MC,CC,QM,CV)
 59 BO   2 NASTRAN data file FORTRAN unit number (40 - 60)
 60 BO   2 Number of augmented nodes (0 if none)
 61 BO   2 Damping matrix option (NS,CD,HL,SD)
 62 BO   2 Constant damping ratio
 63 BO   2 Low frequency, High frequency ratios
 64 BO   2 Mode ID number, damping ratio
 65 BO   2 Conversion factors: Length,Mass,Force
 66 BO   2 Inertia reference node (0=Bdy Ref Frm; 1=mass cen) 1
 67 BO   2 Moments of inertia (kg-m2) Ixx,Iyy,Izz              .8543E12 1.5601E12
 1.3822E12
 68 BO   2 Products of inertia (kg-m2) Ixy,Ixz,Iyz             0 0 0
 69 BO   2 Mass (kg)                                            12666300
 70 BO   2 Number of Nodes                                      5
 71 BO   2 Node ID, Node coord. (meters) x,y,z                  1 298.323 0 0
 72 BO   2 Node ID, Node coord. (meters) x,y,z                  2 0 0 0
 73 BO   2 Node ID, Node coord. (meters) x,y,z                  3 0 0 300
 74 BO   2 Node ID, Node coord. (meters) x,y,z                  4 0 0 -300
 75 BO   2 Node ID, Node coord. (meters) x,y,z                  5 500 0 0
 76 BO   2 Node ID, Node structual joint ID

 77 BO   3 Body ID number                                       3
 78 BO   3 Type (Rigid,Flexible,NASTRAN)                        R
 79 BO   3 Number of modes
 80 BO   3 Modal calculation option (0, 1 or 2)
 81 BO   3 Foreshortening option (Y/N)
 82 BO   3 Model reduction method (NO,MS,MC,CC,QM,CV)
 83 BO   3 NASTRAN data file FORTRAN unit number (40 - 60)
 84 BO   3 Number of augmented nodes (0 if none)
 85 BO   3 Damping matrix option (NS,CD,HL,SD)
 86 BO   3 Constant damping ratio
 87 BO   3 Low frequency, High frequency ratios
 88 BO   3 Mode ID number, damping ratio
```

89	BO	3	Conversion factors: Length,Mass,Force	
90	BO	3	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
91	BO	3	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
92	BO	3	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
93	BO	3	Mass (kg)	2046600
94	BO	3	Number of Nodes	2
95	BO	3	Node ID, Node coord. (meters) x,y,z	1 0 0 0
96	BO	3	Node ID, Node coord. (meters) x,y,z	2 0 0 0
97	BO	3	Node ID, Node structual joint ID	
98	BO	4	Body ID number	4
99	BO	4	Type (Rigid,Flexible,NASTRAN)	R
100	BO	4	Number of modes	
101	BO	4	Modal calculation option (0, 1 or 2)	
102	BO	4	Foreshortening option (Y/N)	
103	BO	4	Model reduction method (NO,MS,MC,CC,QM,CV)	
104	BO	4	NASTRAN data file FORTRAN unit number (40 - 60)	
105	BO	4	Number of augmented nodes (0 if none)	
106	BO	4	Damping matrix option (NS,CD,HL,SD)	
107	BO	4	Constant damping ratio	
108	BO	4	Low frequency, High frequency ratios	
109	BO	4	Mode ID number, damping ratio	
110	BO	4	Conversion factors: Length,Mass,Force	
111	BO	4	Inertia reference node (0=Bdy Ref Frm; 1=mass cen)	1
112	BO	4	Moments of inertia (kg-m2) Ixx,Iyy,Izz	1.7E12 1.7E12 3.4E12
113	BO	4	Products of inertia (kg-m2) Ixy,Ixz,Iyz	0 0 0
114	BO	4	Mass (kg)	2046600
115	BO	4	Number of Nodes	2
116	BO	4	Node ID, Node coord. (meters) x,y,z	1 0 0 0
117	BO	4	Node ID, Node coord. (meters) x,y,z	2 0 0 0
118	BO	4	Node ID, Node structual joint ID	

HINGE

119	HI	1	Hinge ID number	1
120	HI	1	Inboard body ID, Outboard body ID	0 1
121	HI	1	"p" node ID, "q" node ID	0 2
122	HI	1	Number of rotation DOFs, Rotation option (F or G)	3 F
123	HI	1	L1 unit vector in inboard body coord. x,y,z	1 0 0
124	HI	1	L1 unit vector in outboard body coord. x,y,z	1 0 0
125	HI	1	L2 unit vector in inboard body coord. x,y,z	
126	HI	1	L2 unit vector in outboard body coord. x,y,z	
127	HI	1	L3 unit vector in inboard body coord. x,y,z	0 0 1
128	HI	1	L3 unit vector in outboard body coord. x,y,z	0 0 1
129	HI	1	Initial rotation angles (deg)	-90 0 90
130	HI	1	Initial rotation rates (deg/sec)	0 0 0.00417807
131	HI	1	Rotation stiffness (newton-meters/rad)	0 0 0
132	HI	1	Rotation damping (newton-meters/rad/sec)	0 0 0
133	HI	1	Null torque angles (deg)	0 0 0
134	HI	1	Number of translation DOFs	3
135	HI	1	First translation unit vector g1	1 0 0
136	HI	1	Second translation unit vector g2	0 1 0
137	HI	1	Third translation unit vector g3	0 0 1
138	HI	1	Initial translation (meters)	0 0 42163421
139	HI	1	Initial translation velocity (meters/sec)	3074.681 0 0
140	HI	1	Translation stiffness (newtons/meters)	0 0 0
141	HI	1	Translation damping (newtons/meter/sec)	0 0 0
142	HI	1	Null force translations	0 0 0
143	HI	2	Hinge ID number	2
144	HI	2	Inboard body ID, Outboard body ID	1 2
145	HI	2	"p" node ID, "q" node ID	2 2
146	HI	2	Number of rotation DOFs	0
147	HI	2	L1 unit vector in inboard body coord. x,y,z	0 0 1
148	HI	2	L1 unit vector in outboard body coord. x,y,z	0 0 1
149	HI	2	L2 unit vector in inboard body coord. x,y,z	
150	HI	2	L2 unit vector in outboard body coord. x,y,z	
151	HI	2	L3 unit vector in inboard body coord. x,y,z	1 0 0
152	HI	2	L3 unit vector in outboard body coord. x,y,z	1 0 0
153	HI	2	Initial rotation angles (deg)	0 0 0

154	HI	2	Initial rotation rates (deg/sec)	
155	HI	2	Rotation stiffness (newton-meters/rad)	
156	HI	2	Rotation damping (newton-meters/rad/sec)	
157	HI	2	Null torque angles (deg)	
158	HI	2	Number of translation DOFs	0
159	HI	2	First translation unit vector g1	1 0 0
160	HI	2	Second translation unit vector g2	0 1 0
161	HI	2	Third translation unit vector g3	0 0 1
162	HI	2	Initial translation (meters)	0 0 0
163	HI	2	Initial translation velocity (meters/sec)	
164	HI	2	Translation stiffness (newtons/meters)	
165	HI	2	Translation damping (newtons/meter/sec)	
166	HI	2	Null force translations	
167	HI	3	Hinge ID number	3
168	HI	3	Inboard body ID, Outboard body ID	1 3
169	HI	3	"p" node ID, "q" node ID	3 2
170	HI	3	Number of rotation DOFs	3
171	HI	3	L1 unit vector in inboard body coord. x,y,z	0 0 1
172	HI	3	L1 unit vector in outboard body coord. x,y,z	0 0 1
173	HI	3	L2 unit vector in inboard body coord. x,y,z	
174	HI	3	L2 unit vector in outboard body coord. x,y,z	
175	HI	3	L3 unit vector in inboard body coord. x,y,z	0 1 0
176	HI	3	L3 unit vector in outboard body coord. x,y,z	0 1 0
177	HI	3	Initial rotation angles (deg)	-90. 0. -146.75
178	HI	3	Initial rotation rates (deg/sec)	-0.004178 0 0
179	HI	3	Rotation stiffness (newton-meters/rad)	0 0 0
180	HI	3	Rotation damping (newton-meters/rad/sec)	0 0 0
181	HI	3	Null torque angles (deg)	0 0 0
182	HI	3	Number of translation DOFs	0
183	HI	3	First translation unit vector g1	1 0 0
184	HI	3	Second translation unit vector g2	0 1 0
185	HI	3	Third translation unit vector g3	0 0 1
186	HI	3	Initial translation (meters)	0 0 0
187	HI	3	Initial translation velocity (meters/sec)	
188	HI	3	Translation stiffness (newtons/meters)	
189	HI	3	Translation damping (newtons/meter/sec)	
190	HI	3	Null force translations	
191	HI	4	Hinge ID number	4
192	HI	4	Inboard body ID, Outboard body ID	1 4
193	HI	4	"p" node ID, "q" node ID	4 2
194	HI	4	Number of rotation DOFs	3
195	HI	4	L1 unit vector in inboard body coord. x,y,z	0 0 1
196	HI	4	L1 unit vector in outboard body coord. x,y,z	0 0 1
197	HI	4	L2 unit vector in inboard body coord. x,y,z	
198	HI	4	L2 unit vector in outboard body coord. x,y,z	
199	HI	4	L3 unit vector in inboard body coord. x,y,z	0 1 0
200	HI	4	L3 unit vector in outboard body coord. x,y,z	0 1 0
201	HI	4	Initial rotation angles (deg)	-90. 0. -56.75
202	HI	4	Initial rotation rates (deg/sec)	-0.004178 0 0
203	HI	4	Rotation stiffness (newton-meters/rad)	0 0 0
204	HI	4	Rotation damping (newton-meters/rad/sec)	0 0 0
205	HI	4	Null torque angles (deg)	0 0 0
206	HI	4	Number of translation DOFs	0
207	HI	4	First translation unit vector g1	1 0 0
208	HI	4	Second translation unit vector g2	0 1 0
209	HI	4	Third translation unit vector g3	0 0 1
210	HI	4	Initial translation (meters)	0 0 0
211	HI	4	Initial translation velocity (meters/sec)	
212	HI	4	Translation stiffness (newtons/meters)	
213	HI	4	Translation damping (newtons/meter/sec)	
214	HI	4	Null force translations	
			SENSOR	
215	SE	1	Sensor ID number	1
216	SE	1	Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)	ET
217	SE	1	Mounting point body ID, Mounting point node ID	2 2
218	SE	1	Second mounting point body ID, Second node ID	

```
219 SE   1 Input axis unit vector (IA) x,y,z
220 SE   1 Mounting point Hinge index, Axis index
221 SE   1 First focal plane unit vector  (Fp1) x,y,z              0 0 -1
222 SE   1 Second focal plane unit vector (Fp2) x,y,z              0 1 0
223 SE   1 Sun/Star unit vector (Us) x,y,z
224 SE   1 Velocity Aberration Option (Y/N)
225 SE   1 Euler Angle Sequence (1-6)
226 SE   1 CMG ID number and Gimbal number
227 SE   1 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])    6378000 0 0 4.178074D-3

228 SE   2 Sensor ID number                                        2
229 SE   2 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)      ST
230 SE   2 Mounting point body ID, Mounting point node ID          2 2
231 SE   2 Second mounting point body ID, Second node ID
232 SE   2 Input axis unit vector (IA) x,y,z
233 SE   2 Mounting point Hinge index, Axis index
234 SE   2 First focal plane unit vector  (Fp1) x,y,z              0 -1 0
235 SE   2 Second focal plane unit vector (Fp2) x,y,z              1 0 0
236 SE   2 Sun/Star unit vector (Us) x,y,z                         0 1 0
237 SE   2 Velocity Aberration Option (Y/N)                        N
238 SE   2 Euler Angle Sequence (1-6)
239 SE   2 CMG ID number and Gimbal number
240 SE   2 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

241 SE   3 Sensor ID number                                        3
242 SE   3 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)      L
243 SE   3 Mounting point body ID, Mounting point node ID          3 2
244 SE   3 Second mounting point body ID, Second node ID
245 SE   3 Input axis unit vector (IA) x,y,z                       1 2 3
246 SE   3 Mounting point Hinge index, Axis index
247 SE   3 First focal plane unit vector  (Fp1) x,y,z
248 SE   3 Second focal plane unit vector (Fp2) x,y,z
249 SE   3 Sun/Star unit vector (Us) x,y,z
250 SE   3 Velocity Aberration Option (Y/N)
251 SE   3 Euler Angle Sequence (1-6)
252 SE   3 CMG ID number and Gimbal number
253 SE   3 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

254 SE   4 Sensor ID number                                        4
255 SE   4 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)      L
256 SE   4 Mounting point body ID, Mounting point node ID          4 2
257 SE   4 Second mounting point body ID, Second node ID
258 SE   4 Input axis unit vector (IA) x,y,z                       3 2 1
259 SE   4 Mounting point Hinge index, Axis index
260 SE   4 First focal plane unit vector  (Fp1) x,y,z
261 SE   4 Second focal plane unit vector (Fp2) x,y,z
262 SE   4 Sun/Star unit vector (Us) x,y,z
263 SE   4 Velocity Aberration Option (Y/N)
264 SE   4 Euler Angle Sequence (1-6)
265 SE   4 CMG ID number and Gimbal number
266 SE   4 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

267 SE   5 Sensor ID number                                        5
268 SE   5 Type (G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET)      ST
269 SE   5 Mounting point body ID, Mounting point node ID          2 5
270 SE   5 Second mounting point body ID, Second node ID
271 SE   5 Input axis unit vector (IA) x,y,z
272 SE   5 Mounting point Hinge index, Axis index
273 SE   5 First focal plane unit vector  (Fp1) x,y,z              0 0 1
274 SE   5 Second focal plane unit vector (Fp2) x,y,z              0 -1 0
275 SE   5 Sun/Star unit vector (Us) x,y,z                         0 0 0
276 SE   5 Velocity Aberration Option (Y/N)                        N
277 SE   5 Euler Angle Sequence (1-6)
278 SE   5 CMG ID number and Gimbal number
279 SE   5 Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])

280 SE   6 Sensor ID number                                        6
281 SE   6 Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV      A3
282 SE   6 Mounting point body ID, Mounting point node ID          2 2
283 SE   6 Second mounting point body ID, Second node ID
284 SE   6 Input axis unit vector (IA) x,y,z
```

285	SE	6	Mounting point Hinge index, Axis index	
286	SE	6	First focal plane unit vector (Fp1) x,y,z	
287	SE	6	Second focal plane unit vector (Fp2) x,y,z	
288	SE	6	Sun/Star unit vector (Us) x,y,z	
289	SE	6	Velocity Aberration Option (Y/N)	
290	SE	6	Euler Angle Sequence (1-6)	
291	SE	6	CMG ID number and Gimbal number	
292	SE	6	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	
293	SE	7	Sensor ID number	7
294	SE	7	Typ(G,R,AN,V,P,AC,T,I,SU,ST,L,IM,P3,V3,CR,CT,ET,LV	AC
295	SE	7	Mounting point body ID, Mounting point node ID	2 2
296	SE	7	Second mounting point body ID, Second node ID	
297	SE	7	Input axis unit vector (IA) x,y,z	1 0 0
298	SE	7	Mounting point Hinge index, Axis index	
299	SE	7	First focal plane unit vector (Fp1) x,y,z	
300	SE	7	Second focal plane unit vector (Fp2) x,y,z	
301	SE	7	Sun/Star unit vector (Us) x,y,z	
302	SE	7	Velocity Aberration Option (Y/N)	
303	SE	7	Euler Angle Sequence (1-6)	
304	SE	7	CMG ID number and Gimbal number	
305	SE	7	Earth pt (rad,lat,lon,rotation [m/e, d, d, d/s])	

ACTR

306	AC	1	Actuator ID number	1
307	AC	1	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
308	AC	1	Actuator location; Node or Hinge (N or H)	
309	AC	1	Mounting point body ID number, node ID number	2 2
310	AC	1	Second mounting point body ID, second node ID	
311	AC	1	Output axis unit vector x,y,z	0 1 0
312	AC	1	Mounting point Hinge index, Axis index	
313	AC	1	Rotor spin axis unit vector x,y,z	
314	AC	1	Initial rotor momentum, H	
315	AC	1	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
316	AC	1	Outer gimbal axis unit vector x,y,z	
317	AC	1	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
318	AC	1	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
319	AC	1	Inner gimbal axis unit vector x,y,z	
320	AC	1	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
321	AC	1	Initial length and rate, y(to) and ydot(to)	
322	AC	1	Constants; K1 or wo, n or zeta, Kg, Jm	
323	AC	1	Non-linearities; TLim, Tco, Dz	
324	AC	2	Actuator ID number	2
325	AC	2	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
326	AC	2	Actuator location; Node or Hinge (N or H)	
327	AC	2	Mounting point body ID number, node ID number	2 2
328	AC	2	Second mounting point body ID, second node ID	
329	AC	2	Output axis unit vector x,y,z	0 0 1
330	AC	2	Mounting point Hinge index, Axis index	
331	AC	2	Rotor spin axis unit vector x,y,z	
332	AC	2	Initial rotor momentum, H	
333	AC	2	Outer gimbal- angle(deg),inertia,friction(D,S,B,N)	
334	AC	2	Outer gimbal axis unit vector x,y,z	
335	AC	2	Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
336	AC	2	Inner gimbal- angle(deg),inertia,friction(D,S,B,N)	
337	AC	2	Inner gimbal axis unit vector x,y,z	
338	AC	2	In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)	
339	AC	2	Initial length and rate, y(to) and ydot(to)	
340	AC	2	Constants; K1 or wo, n or zeta, Kg, Jm	
341	AC	2	Non-linearities; TLim, Tco, Dz	
342	AC	3	Actuator ID number	3
343	AC	3	Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)	MO
344	AC	3	Actuator location; Node or Hinge (N or H)	
345	AC	3	Mounting point body ID number, node ID number	2 2
346	AC	3	Second mounting point body ID, second node ID	
347	AC	3	Output axis unit vector x,y,z	1 0 0
348	AC	3	Mounting point Hinge index, Axis index	

```
349 AC   3 Rotor spin axis unit vector x,y,z
350 AC   3 Initial rotor momentum, H
351 AC   3 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
352 AC   3 Outer gimbal axis unit vector x,y,z
353 AC   3 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
354 AC   3 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
355 AC   3 Inner gimbal axis unit vector x,y,z
356 AC   3 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
357 AC   3 Initial length and rate, y(to) and ydot(to)
358 AC   3 Constants; K1 or wo, n or zeta, Kg, Jm
359 AC   3 Non-linearities; TLim, Tco, Dz

360 AC   4 Actuator ID number                                   4
361 AC   4 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
362 AC   4 Actuator location; Node or Hinge (N or H)
363 AC   4 Mounting point body ID number, node ID number        3 2
364 AC   4 Second mounting point body ID, second node ID
365 AC   4 Output axis unit vector x,y,z                        1 0 0
366 AC   4 Mounting point Hinge index, Axis index
367 AC   4 Rotor spin axis unit vector x,y,z
368 AC   4 Initial rotor momentum, H
369 AC   4 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
370 AC   4 Outer gimbal axis unit vector x,y,z
371 AC   4 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
372 AC   4 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
373 AC   4 Inner gimbal axis unit vector x,y,z
374 AC   4 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
375 AC   4 Initial length and rate, y(to) and ydot(to)
376 AC   4 Constants; K1 or wo, n or zeta, Kg, Jm
377 AC   4 Non-linearities; TLim, Tco, Dz

378 AC   5 Actuator ID number                                   5
379 AC   5 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
380 AC   5 Actuator location; Node or Hinge (N or H)
381 AC   5 Mounting point body ID number, node ID number        3 2
382 AC   5 Second mounting point body ID, second node ID
383 AC   5 Output axis unit vector x,y,z                        0 1 0
384 AC   5 Mounting point Hinge index, Axis index
385 AC   5 Rotor spin axis unit vector x,y,z
386 AC   5 Initial rotor momentum, H
387 AC   5 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
388 AC   5 Outer gimbal axis unit vector x,y,z
389 AC   5 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
390 AC   5 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
391 AC   5 Inner gimbal axis unit vector x,y,z
392 AC   5 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
393 AC   5 Initial length and rate, y(to) and ydot(to)
394 AC   5 Constants; K1 or wo, n or zeta, Kg, Jm
395 AC   5 Non-linearities; TLim, Tco, Dz

396 AC   6 Actuator ID number                                   6
397 AC   6 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
398 AC   6 Actuator location; Node or Hinge (N or H)
399 AC   6 Mounting point body ID number, node ID number        3 2
400 AC   6 Second mounting point body ID, second node ID
401 AC   6 Output axis unit vector x,y,z                        0 0 1
402 AC   6 Mounting point Hinge index, Axis index
403 AC   6 Rotor spin axis unit vector x,y,z
404 AC   6 Initial rotor momentum, H
405 AC   6 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
406 AC   6 Outer gimbal axis unit vector x,y,z
407 AC   6 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
408 AC   6 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
409 AC   6 Inner gimbal axis unit vector x,y,z
410 AC   6 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
411 AC   6 Initial length and rate, y(to) and ydot(to)
412 AC   6 Constants; K1 or wo, n or zeta, Kg, Jm
413 AC   6 Non-linearities; TLim, Tco, Dz

414 AC   7 Actuator ID number                                   7
415 AC   7 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
```

```
416 AC    7 Actuator location; Node or Hinge (N or H)
417 AC    7 Mounting point body ID number, node ID number        4 2
418 AC    7 Second mounting point body ID, second node ID
419 AC    7 Output axis unit vector x,y,z                        1 0 0
420 AC    7 Mounting point Hinge index, Axis index
421 AC    7 Rotor spin axis unit vector x,y,z
422 AC    7 Initial rotor momentum, H
423 AC    7 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
424 AC    7 Outer gimbal axis unit vector x,y,z
425 AC    7 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
426 AC    7 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
427 AC    7 Inner gimbal axis unit vector x,y,z
428 AC    7 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
429 AC    7 Initial length and rate, y(to) and ydot(to)
430 AC    7 Constants; K1 or wo, n or zeta, Kg, Jm
431 AC    7 Non-linearities; TLim, Tco, Dz

432 AC    8 Actuator ID number                                   8
433 AC    8 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7)                  MO
434 AC    8 Actuator location; Node or Hinge (N or H)
435 AC    8 Mounting point body ID number, node ID number        4 2
436 AC    8 Second mounting point body ID, second node ID
437 AC    8 Output axis unit vector x,y,z                        0 1 0
438 AC    8 Mounting point Hinge index, Axis index
439 AC    8 Rotor spin axis unit vector x,y,z
440 AC    8 Initial rotor momentum, H
441 AC    8 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
442 AC    8 Outer gimbal axis unit vector x,y,z
443 AC    8 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
444 AC    8 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
445 AC    8 Inner gimbal axis unit vector x,y,z
446 AC    8 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
447 AC    8 Initial length and rate, y(to) and ydot(to)
448 AC    8 Constants; K1 or wo, n or zeta, Kg, Jm
449 AC    8 Non-linearities; TLim, Tco, Dz

450 AC    9 Actuator ID number                                   9
451 AC    9 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)               MO
452 AC    9 Actuator location; Node or Hinge (N or H)
453 AC    9 Mounting point body ID number, node ID number        4 2
454 AC    9 Second mounting point body ID, second node ID
455 AC    9 Output axis unit vector x,y,z                        0 0 1
456 AC    9 Mounting point Hinge index, Axis index
457 AC    9 Rotor spin axis unit vector x,y,z
458 AC    9 Initial rotor momentum, H
459 AC    9 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
460 AC    9 Outer gimbal axis unit vector x,y,z
461 AC    9 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
462 AC    9 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
463 AC    9 Inner gimbal axis unit vector x,y,z
464 AC    9 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
465 AC    9 Initial length and rate, y(to) and ydot(to)
466 AC    9 Constants; K1 or wo, n or zeta, Kg, Jm
467 AC    9 Non-linearities; TLim, Tco, Dz

468 AC   10 Actuator ID number                                   10
469 AC   10 Type(J,H,MO,T,B,MA,SG,DG,W,L,M1-M7,US)               J
470 AC   10 Actuator location; Node or Hinge (N or H)
471 AC   10 Mounting point body ID number, node ID number        2 5
472 AC   10 Second mounting point body ID, second node ID
473 AC   10 Output axis unit vector x,y,z                        -1 0 0
474 AC   10 Mounting point Hinge index, Axis index
475 AC   10 Rotor spin axis unit vector x,y,z
476 AC   10 Initial rotor momentum, H
477 AC   10 Outer gimbal- angle(deg),inertia,friction(D,S,B,N)
478 AC   10 Outer gimbal axis unit vector x,y,z
479 AC   10 Out gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
480 AC   10 Inner gimbal- angle(deg),inertia,friction(D,S,B,N)
481 AC   10 Inner gimbal axis unit vector x,y,z
482 AC   10 In gim fric (Tfi,Tgfo,GAM)/(Tfi,M,D,Kf)/(m,M,B,k)
483 AC   10 Initial length and rate, y(to) and ydot(to)
```

484	AC	10	Constants; K1 or wo, n or zeta, Kg, Jm	
485	AC	10	Non-linearities; TLim, Tco, Dz	
			CONTROLLER	
486	CO	1	Controller ID number	1
487	CO	1	Controller type (CB,CM,DB,DM,UC,UD)	CM
488	CO	1	Sample time (sec)	
489	CO	1	Number of inputs, Number of outputs	9 9
490	CO	1	Number of states	
491	CO	1	Output No., Input type (I,S,T), Input ID, Gain	
			INTERCONNECT	
492	IN	1	Interconnect ID number	1
493	IN	1	Source type(S,C, or F),Source ID,Source row #	S 1 1
494	IN	1	Destination type(A or C),Dest ID,Dest row #	C 1 1
495	IN	1	Gain	4.41E13
496	IN	2	Interconnect ID number	2
497	IN	2	Source type(S,C, or F),Source ID,Source row #	C 1 1
498	IN	2	Destination type(A or C),Dest ID,Dest row #	A 1 1
499	IN	2	Gain	1
500	IN	3	Interconnect ID number	3
501	IN	3	Source type(S,C, or F),Source ID,Source row #	S 1 2
502	IN	3	Destination type(A or C),Dest ID,Dest row #	C 1 2
503	IN	3	Gain	1.67E12
504	IN	4	Interconnect ID number	4
505	IN	4	Source type(S,C, or F),Source ID,Source row #	C 1 2
506	IN	4	Destination type(A or C),Dest ID,Dest row #	A 2 1
507	IN	4	Gain	1
508	IN	5	Interconnect ID number	5
509	IN	5	Source type(S,C, or F),Source ID,Source row #	S 2 1
510	IN	5	Destination type(A or C),Dest ID,Dest row #	C 1 3
511	IN	5	Gain	4.31E13
512	IN	6	Interconnect ID number	6
513	IN	6	Source type(S,C, or F),Source ID,Source row #	C 1 3
514	IN	6	Destination type(A or C),Dest ID,Dest row #	A 3 1
515	IN	6	Gain	1
516	IN	7	Interconnect ID number	7
517	IN	7	Source type(S,C, or F),Source ID,Source row #	S 3 1
518	IN	7	Destination type(A or C),Dest ID,Dest row #	C 1 4
519	IN	7	Gain	1.7E12
520	IN	8	Interconnect ID number	8
521	IN	8	Source type(S,C, or F),Source ID,Source row #	C 1 4
522	IN	8	Destination type(A or C),Dest ID,Dest row #	A 4 1
523	IN	8	Gain	1
524	IN	9	Interconnect ID number	9
525	IN	9	Source type(S,C, or F),Source ID,Source row #	S 3 2
526	IN	9	Destination type(A or C),Dest ID,Dest row #	C 1 5
527	IN	9	Gain	1.7E12
528	IN	10	Interconnect ID number	10
529	IN	10	Source type(S,C, or F),Source ID,Source row #	C 1 5
530	IN	10	Destination type(A or C),Dest ID,Dest row #	A 5 1
531	IN	10	Gain	1
532	IN	11	Interconnect ID number	11
533	IN	11	Source type(S,C, or F),Source ID,Source row #	S 3 3
534	IN	11	Destination type(A or C),Dest ID,Dest row #	C 1 6
535	IN	11	Gain	3.4E12

```
536 IN  12 Interconnect ID number                                  12
537 IN  12 Source type(S,C, or F),Source ID,Source row #           C 1 6
538 IN  12 Destination type(A or C),Dest ID,Dest row #             A 6 1
539 IN  12 Gain                                                    1

540 IN  13 Interconnect ID number                                  13
541 IN  13 Source type(S,C, or F),Source ID,Source row #           S 4 1
542 IN  13 Destination type(A or C),Dest ID,Dest row #             C 1 7
543 IN  13 Gain                                                    1.7E12

544 IN  14 Interconnect ID number                                  14
545 IN  14 Source type(S,C, or F),Source ID,Source row #           C 1 7
546 IN  14 Destination type(A or C),Dest ID,Dest row #             A 7 1
547 IN  14 Gain                                                    1

548 IN  15 Interconnect ID number                                  15
549 IN  15 Source type(S,C, or F),Source ID,Source row #           S 4 2
550 IN  15 Destination type(A or C),Dest ID,Dest row #             C 1 8
551 IN  15 Gain                                                    1.7E12

552 IN  16 Interconnect ID number                                  16
553 IN  16 Source type(S,C, or F),Source ID,Source row #           C 1 8
554 IN  16 Destination type(A or C),Dest ID,Dest row #             A 8 1
555 IN  16 Gain                                                    1

556 IN  17 Interconnect ID number                                  17
557 IN  17 Source type(S,C, or F),Source ID,Source row #           S 4 3
558 IN  17 Destination type(A or C),Dest ID,Dest row #             C 1 9
559 IN  17 Gain                                                    3.4E12

560 IN  18 Interconnect ID number                                  18
561 IN  18 Source type(S,C, or F),Source ID,Source row #           C 1 9
562 IN  18 Destination type(A or C),Dest ID,Dest row #             A 9 1
563 IN  18 Gain                                                    1

564 IN  19 Interconnect ID number                                  19
565 IN  19 Source type(S,C, or F),Source ID,Source row #           S 5 3
566 IN  19 Destination type(A or C),Dest ID,Dest row #             A 10 1
567 IN  19 Gain                                                    7
```

Appendix B

Comparison of Results for ISC Four Control Concepts over Four Seasonal Transitions

Results for the SSP ISC TREETOPS simulation for four control concepts over seasonal transitions are presented in this appendix. In general, time histories of control errors, accelerations, contol torques, power beam force, flexible translations and rotations, hinge forces and hinge torques and relative translations are presented. Concepts reported were concept 1, concept 2A, concept 2B and concept 3. The four seasonal transitions were reported for concept 1 and concept 3: Vernal Equinox, Summer Solstice, Autumnal Equinox and Winter Solstice. For concepts 2A and 2B, only Summer Solstice was reported. The intent was to present the steady-state attributes of the system. Therefore, reported data generally starts at 2 hours, after most of the transients have subsided. Typically, plotted data is reported for 25.8 hrs, just over a day. Also, there are some additional plots with plotted data over a period of approximately 10 days for Vernal Equinox, cases 1 and 3.

In addition, thrust requirements, for control and station keeping, were evaluated and are presented herein. Cumulative thrust curves are presented over a one-day period. Thrust requirements for each control component and for each season are investegated. Tables are also given to summarize the information. One day and one year thrust requirements are presented.

This Appendix is organized as follows:

(Later, it was realized that the initial conditions for body 3 and 4 (UC and LC) for concept 1 VE, AE, and WS were not entirely correct. For concept 1 VE, AE and WS, the initial conditions for UC and LC pitch angle were correct, but the initial condition for the UC and LC yaw angle with respect to the boom was not correct. Therefore, Tables B.1-5 through B.1-8 supercede Tables B.1-1 through B.1-4 for concept 1.)

B.1 TREETOPS simulation results and Thrust Requirements for Concept 1

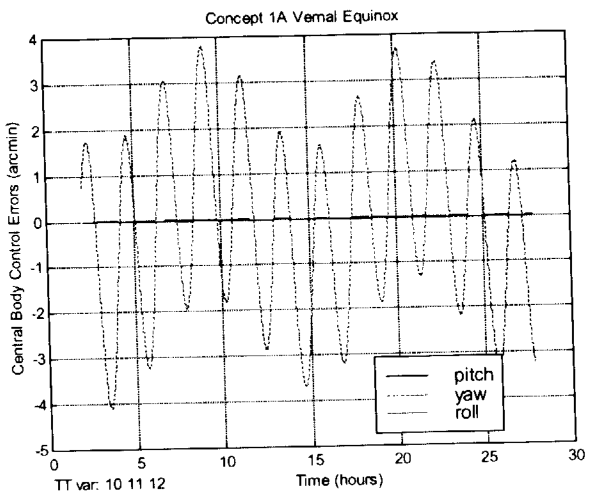


Figure B.1-1a: Central Body Control Errors vs. Time (Vernal Equinox)

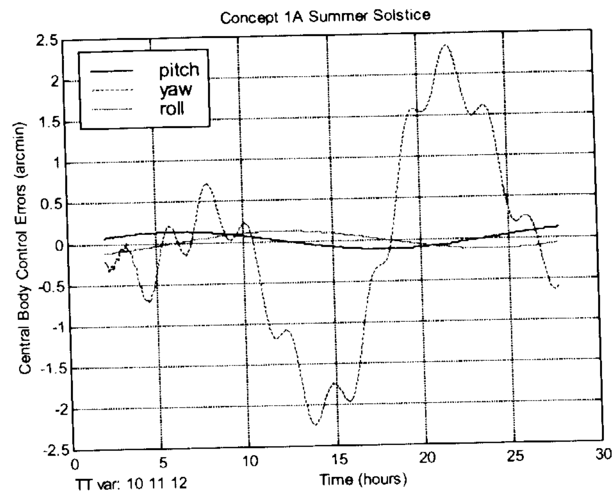


Figure B.1-1b: Central Body Control Errors vs. Time (Summer Solstice)

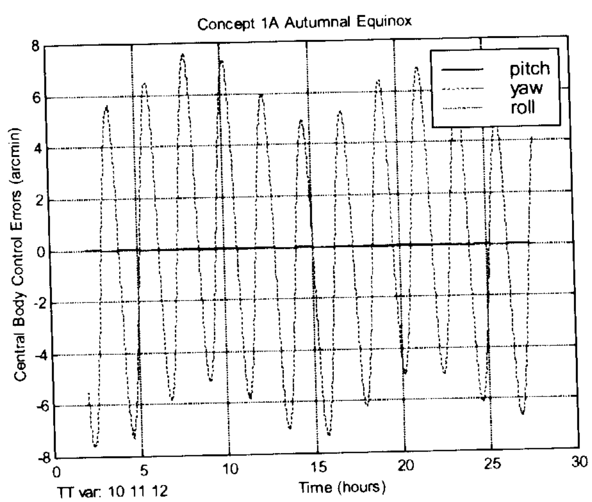


Figure B.1-1c: Central Body Control Errors vs. Time (Autumnal Equinox)

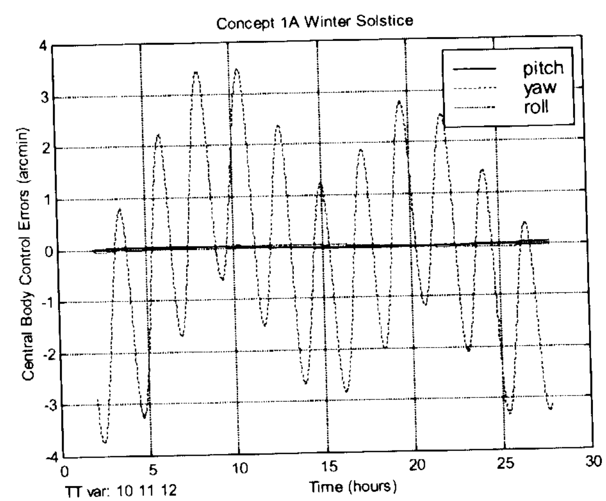


Figure B.1-1d: Central Body Control Errors vs. Time (Winter Solstice)

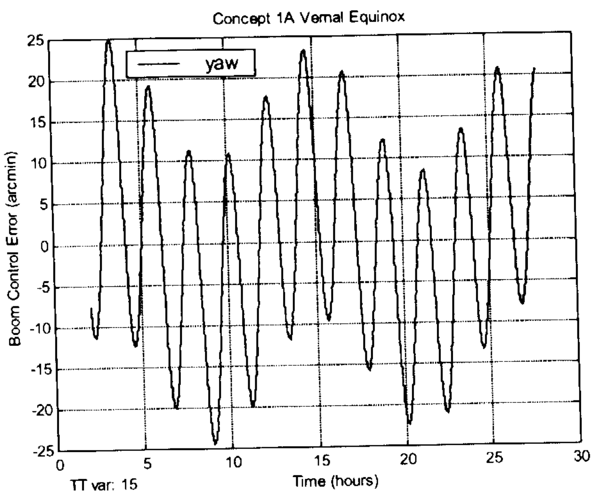


Figure B.1-2a: Boom Control Errors vs. Time (Vernal Equinox)

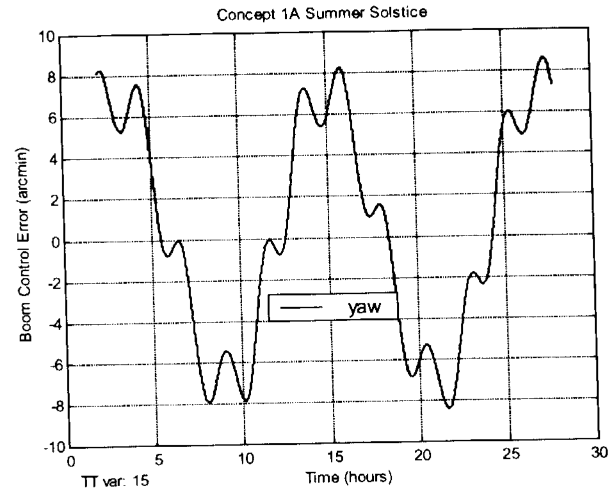


Figure B.1-2b: Boom Control Errors vs. Time (Summer Solstice)

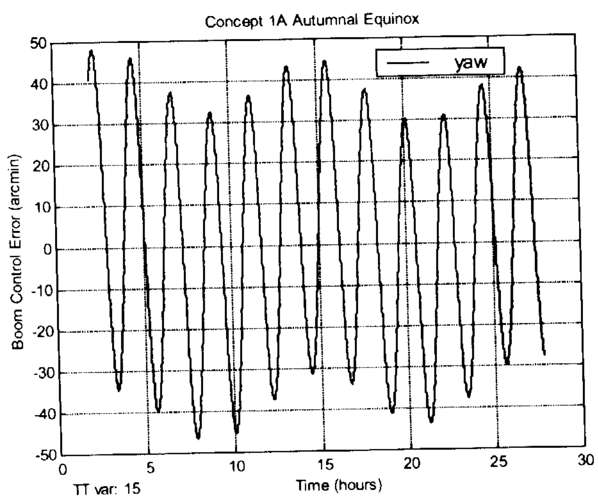


Figure B.1-2c: Boom Control Errors vs. Time (Autumnal Equinox)

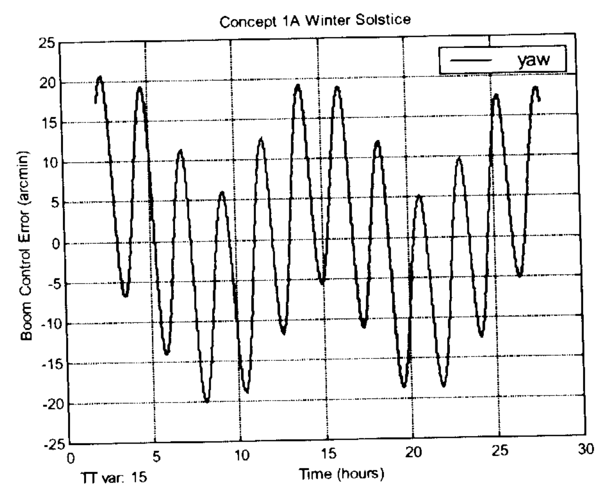


Figure B.1-2d: Boom Control Errors vs. Time (Winter Solstice

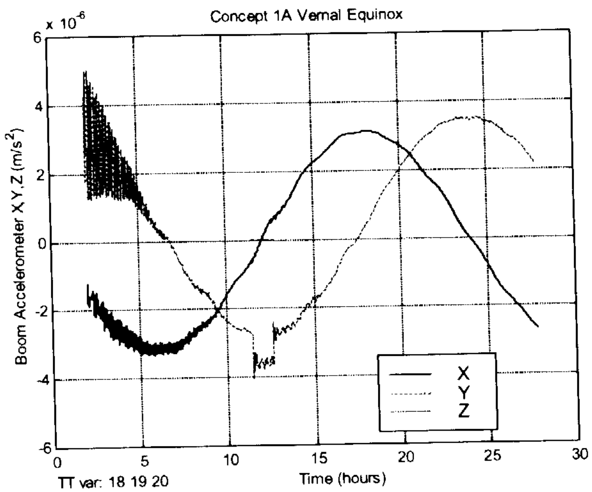


Figure B.1-3a: Boom Accelerometer vs. Time
(Vernal Equinox)

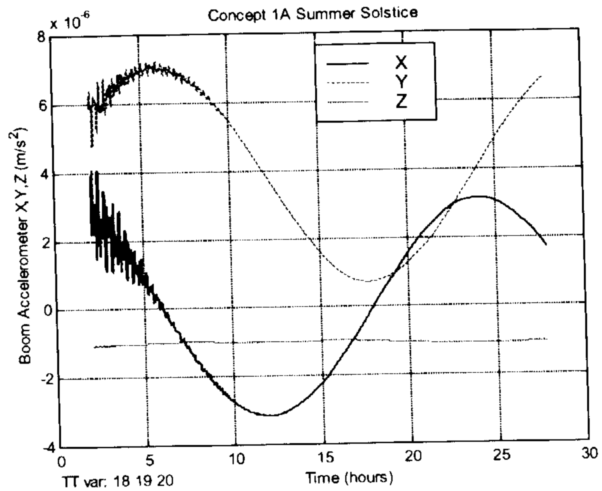


Figure B.1-3b: Boom Accelerometer vs. Time
(Summer Solstice)

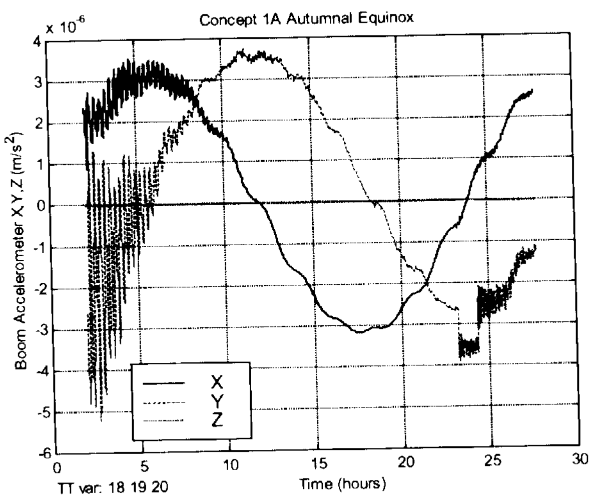


Figure B.1-3c: Boom Accelerometer vs. Time
(Autumnal Equinox)

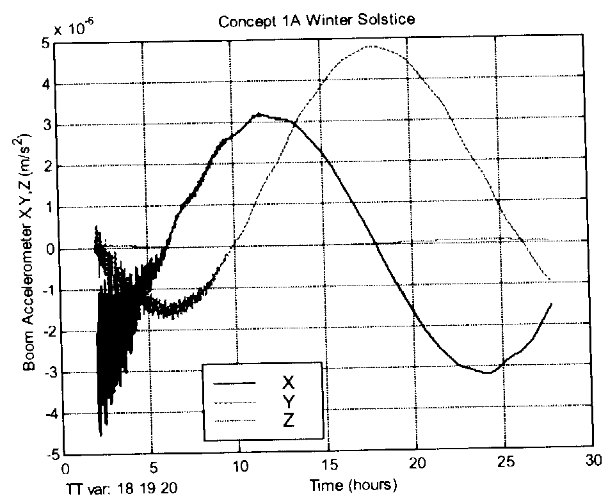


Figure B.1-3d: Boom Accelerometer vs. Time
(Winter Solstice)

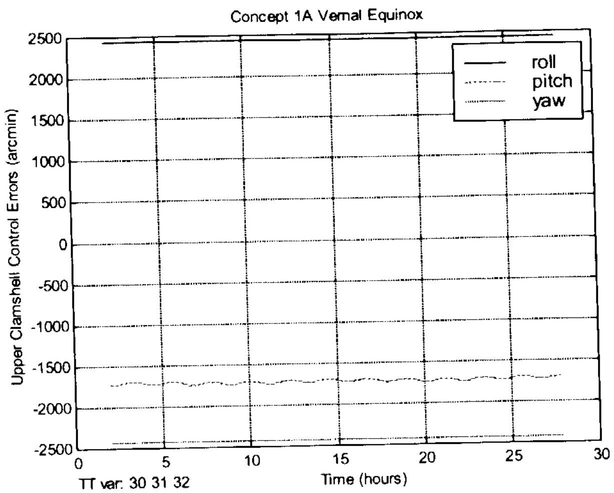


Figure B.1-4a: Upper Clamshell Control Errors vs. Time (Vernal Equinox)

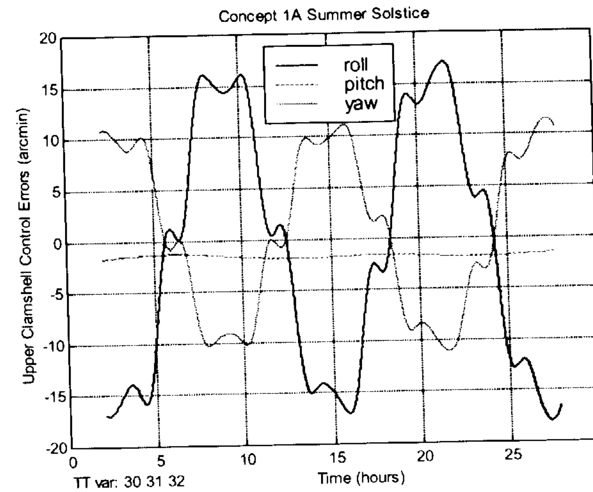


Figure B.1-4b: Upper Clamshell Control Errors vs. Time (Summer Solstice)

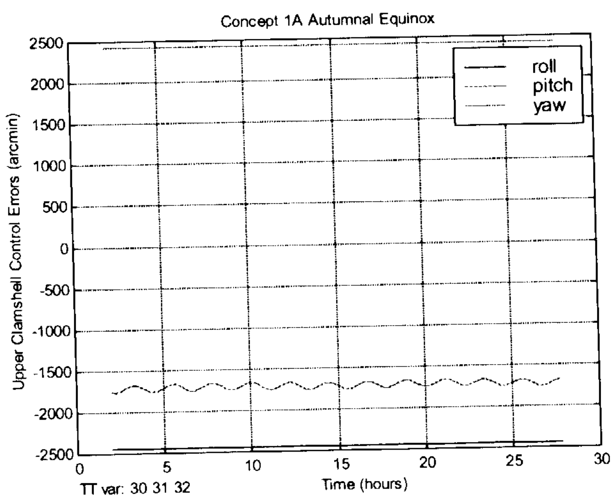


Figure B.1-4c: Upper Clamshell Control Errors vs. Time (Autumnal Equinox)

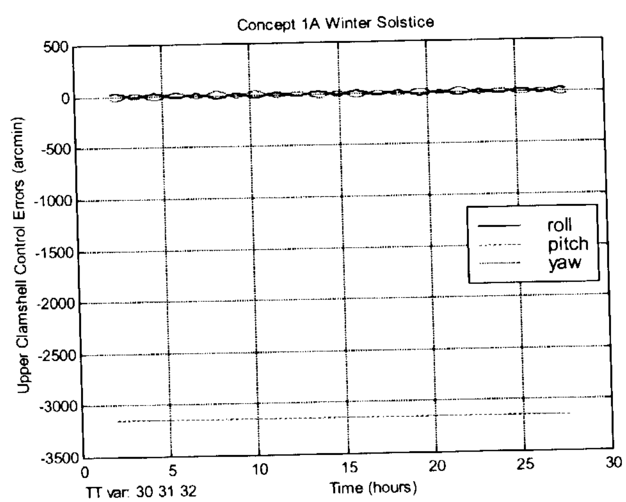


Figure B.1-4d: Upper Clamshell Control Errors vs. Time (Winter Solstice)

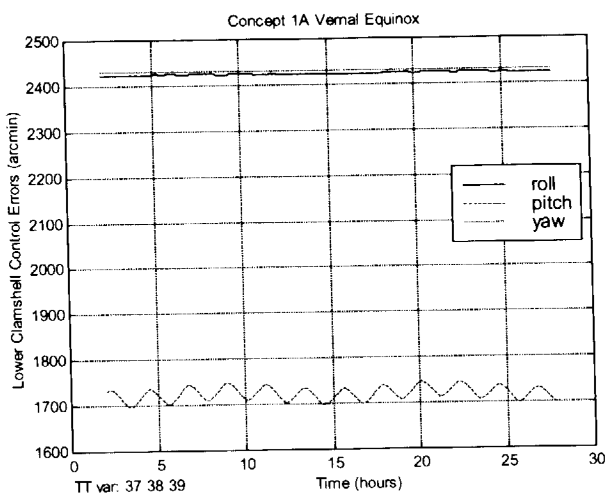


Figure B.1-5a: Lower Clamshell Control Errors vs. Time
(Vernal Equinox)

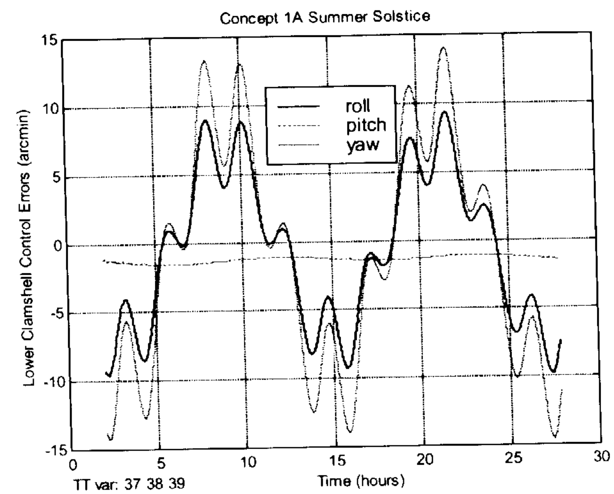


Figure B.1-5b: Lower Clamshell Control Errors vs. Time
(Summer Solstice)

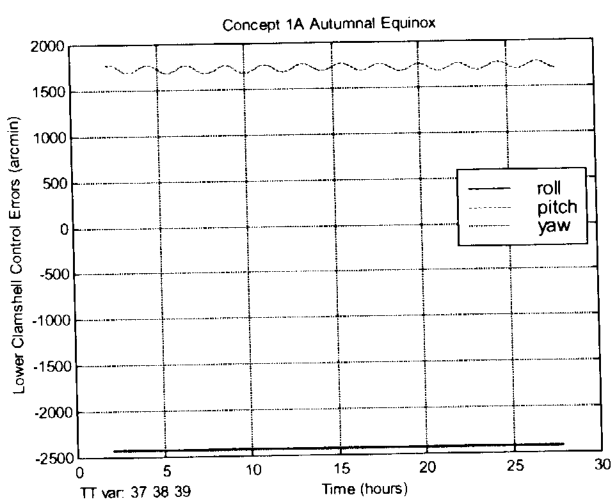


Figure B.1-5c: Lower Clamshell Control Errors vs. Time
(Autumnal Equinox)

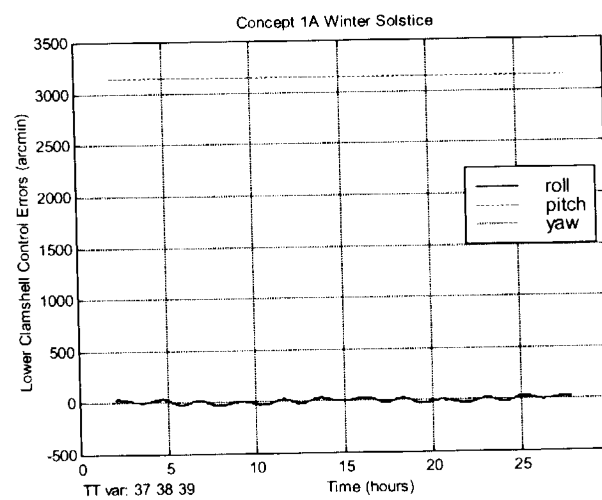


Figure B.1-5d: Lower Clamshell Control Errors vs. Time
(Winter Solstice)

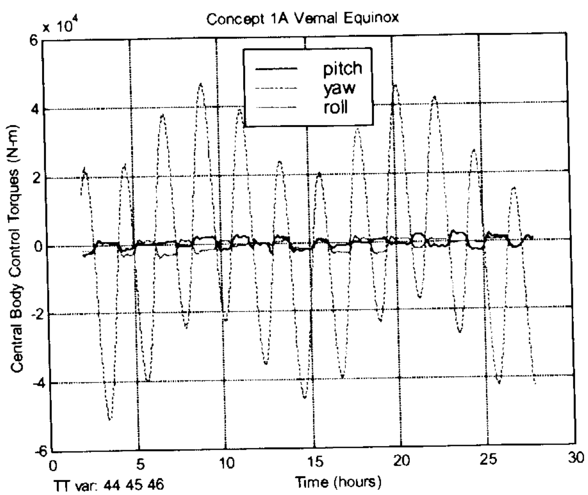


Figure B.1-6a: Central Body Control Torques vs. Time (Vernal Equinox)

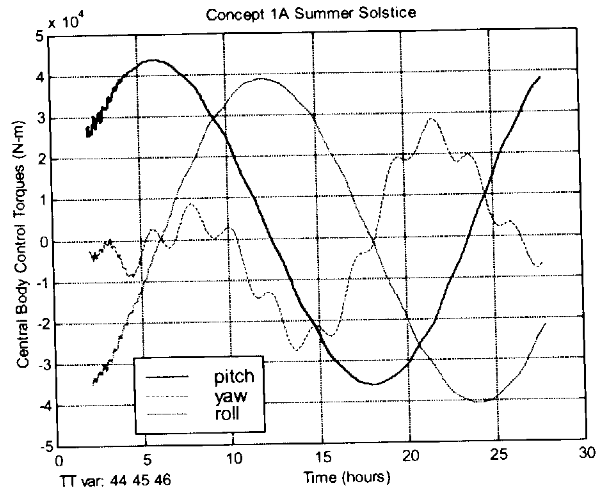


Figure B.1-6b: Central Body Control Torques vs. Time (Summer Solstice)

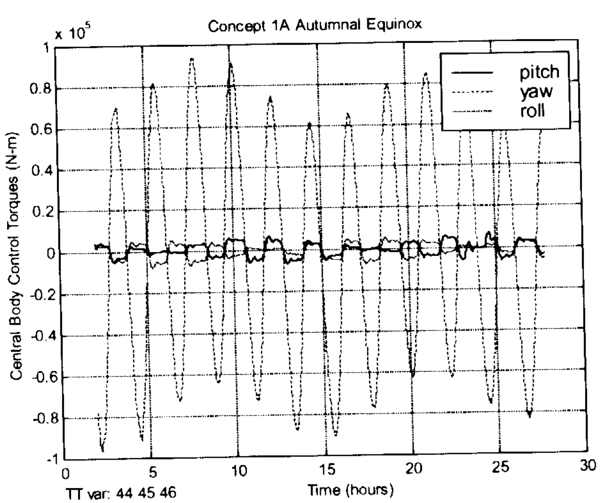


Figure B.1-6c: Central Body Control Torques vs. Time (Autumnal Equinox)

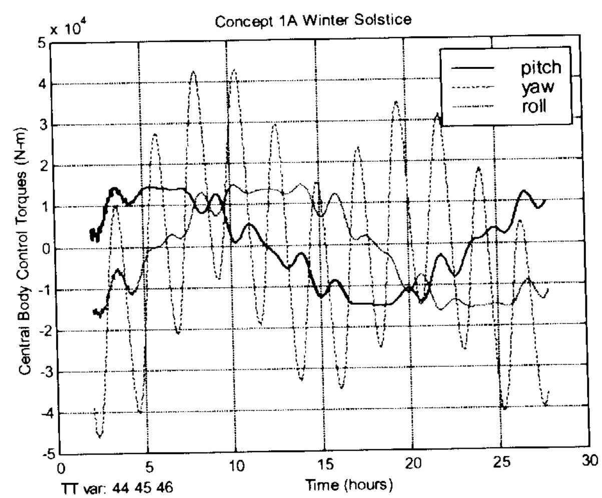


Figure B.1-6d: Central Body Control Torques vs. Time (Winter Solstice)

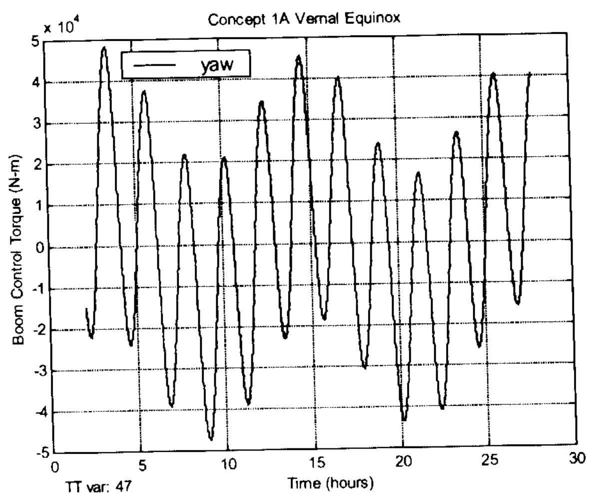


Figure B.1-7a: Boom Control Torques vs. Time (Vernal Equinox)

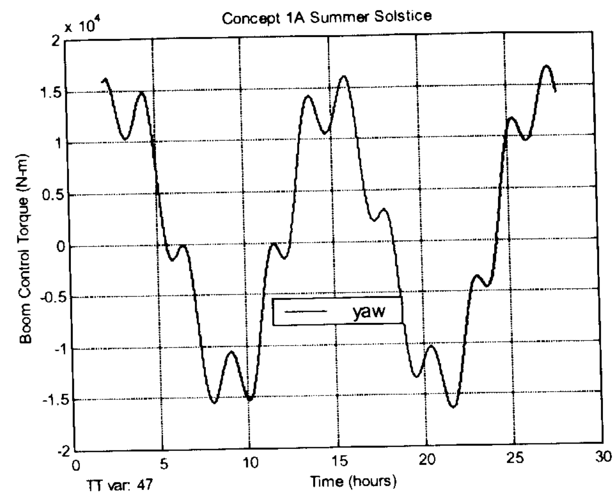


Figure B.1-7b: Boom Control Torques vs. Time (Summer Solstice)

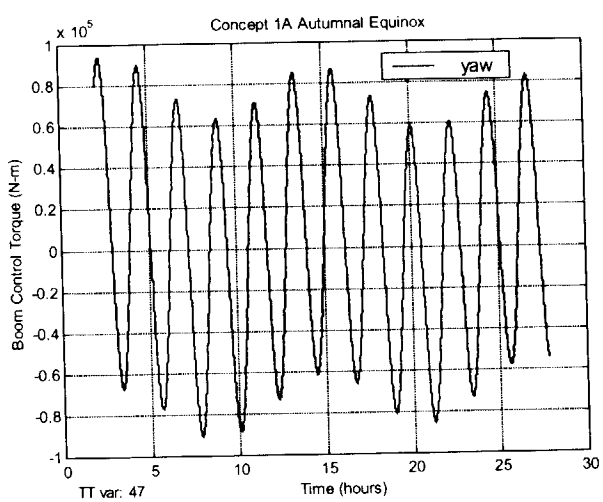


Figure B.1-7c: Boom Control Torques vs. Time (Autumnal Equinox)

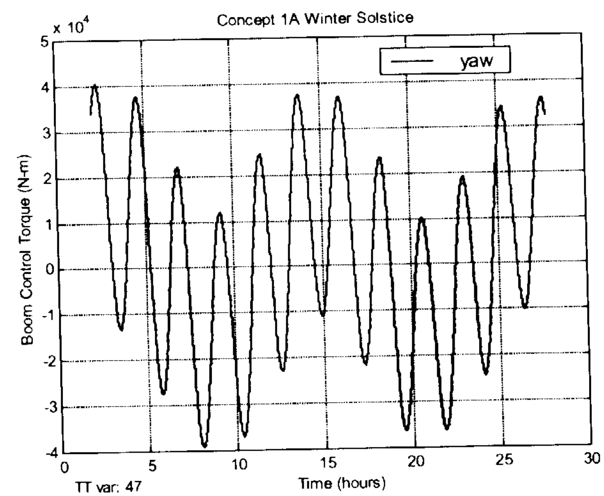


Figure B.1-7d: Boom Control Torques vs. Time (Winter Solstice)

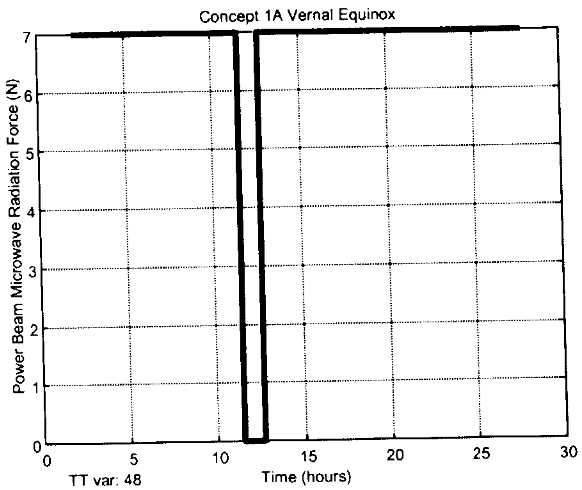


Figure B.1-8a: Power Beam Microwave Radiation Force vs. Time
(Vernal Equinox)

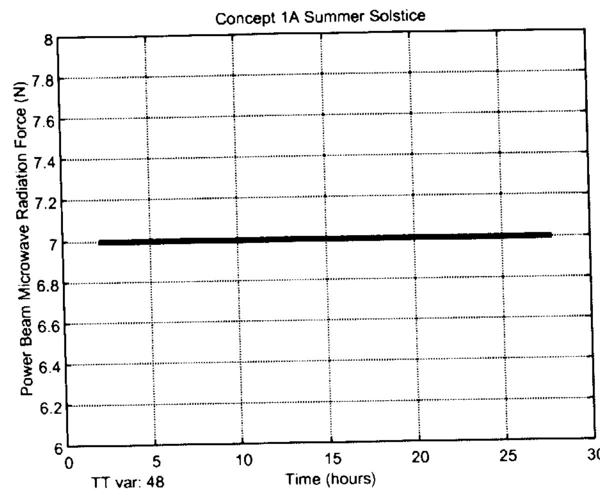


Figure B.1-8b: Power Beam Microwave Radiation Force
vs. Time
(Summer Solstice)

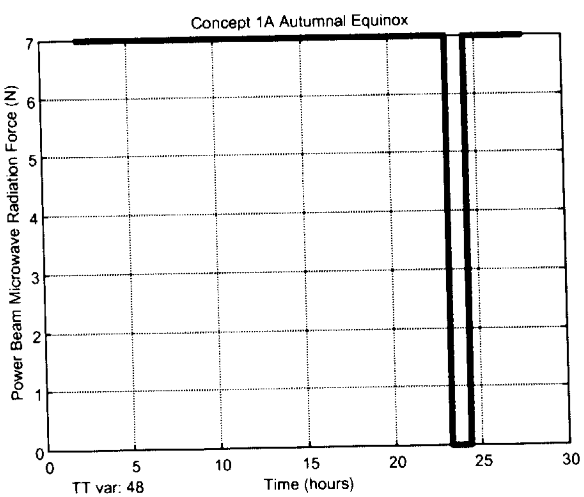


Figure B.1-8c: Power Beam Microwave Radiation Force
vs. Time
(Autumnal Equinox)

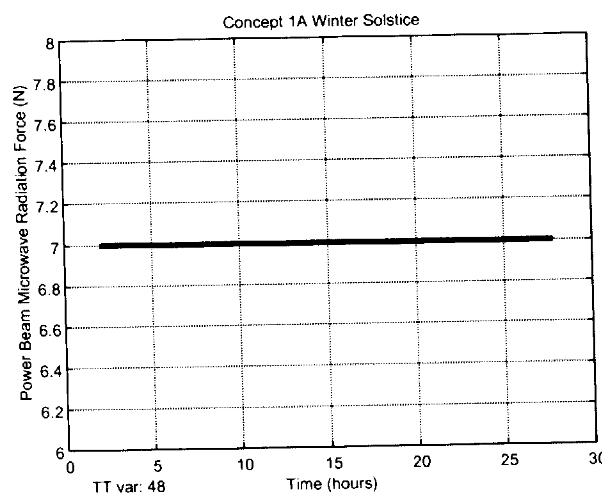


Figure B.1-8d: Power Beam Microwave Radiation Force
vs. Time
(Winter Solstice)

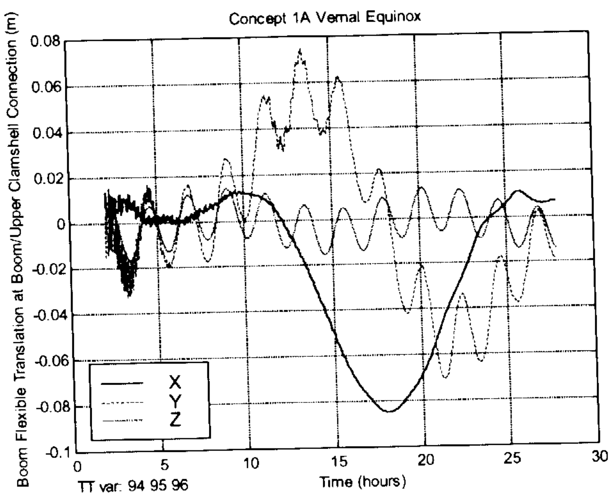


Figure B.1-9a: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

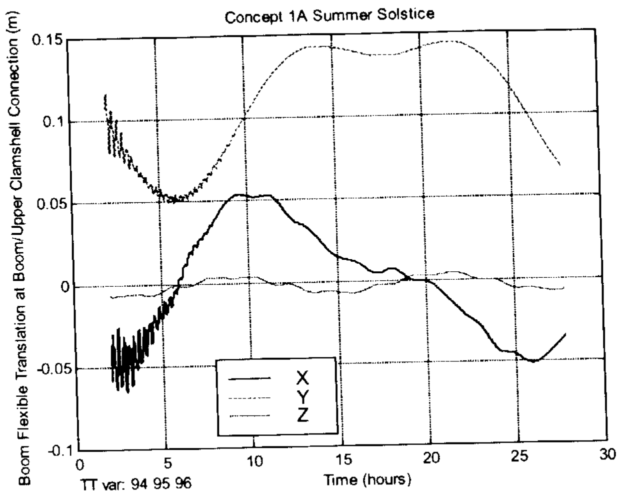


Figure B.1-9b: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Summer Solstice)

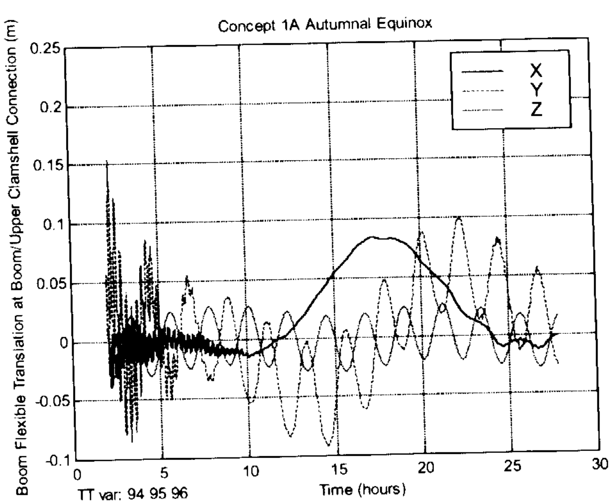


Figure B.1-9c: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Autumnal Equinox)

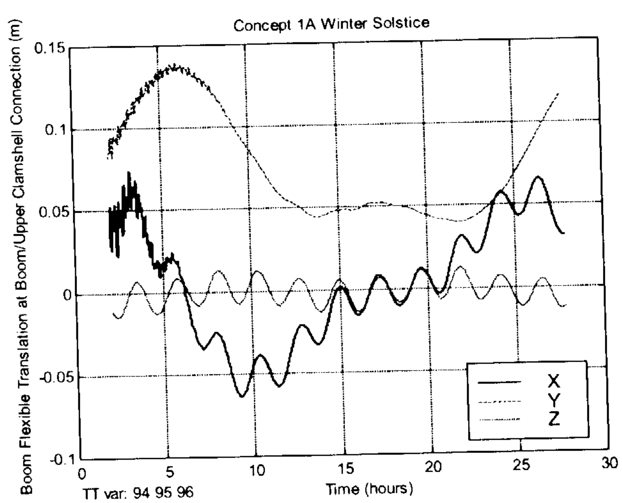


Figure B.1-9d: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Winter Solstice)

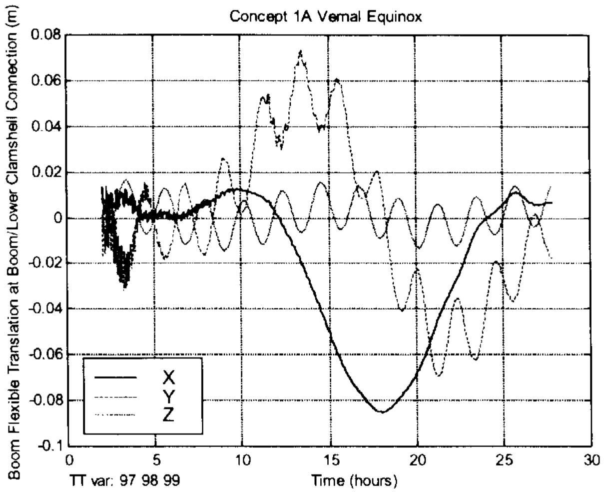


Figure B.1-10a: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

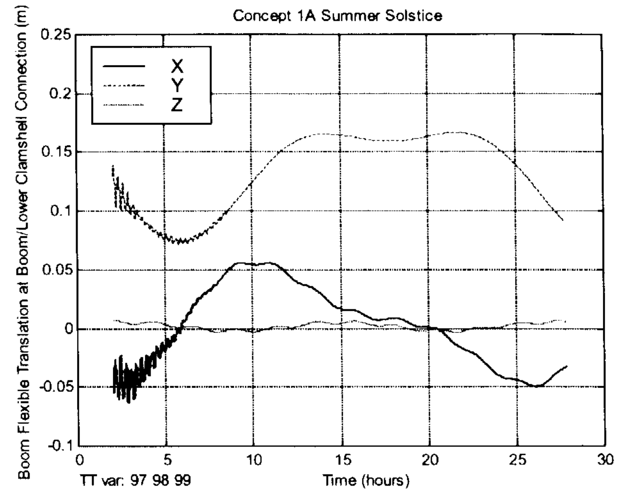


Figure B.1-10b: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Summer Solstice)

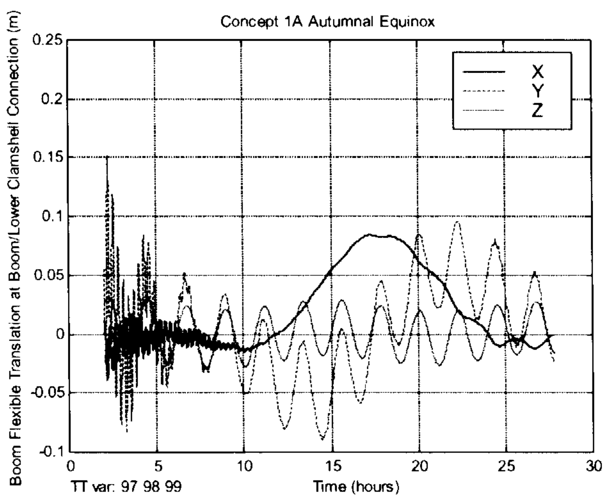


Figure B.1-10c: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Autumnal Equinox)

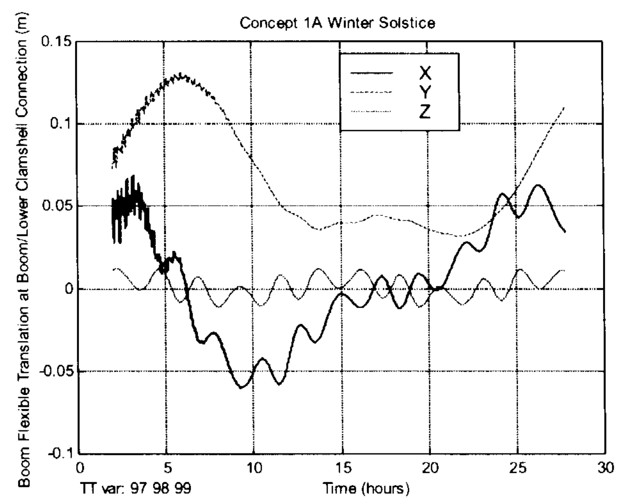


Figure B.1-10d: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Winter Solstice)

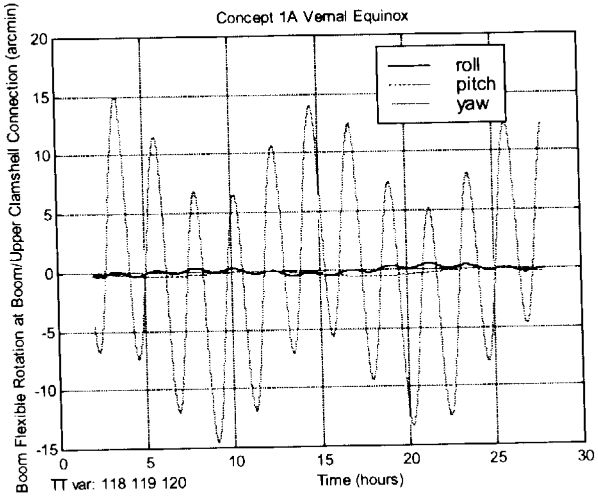


Figure B.1-11a: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

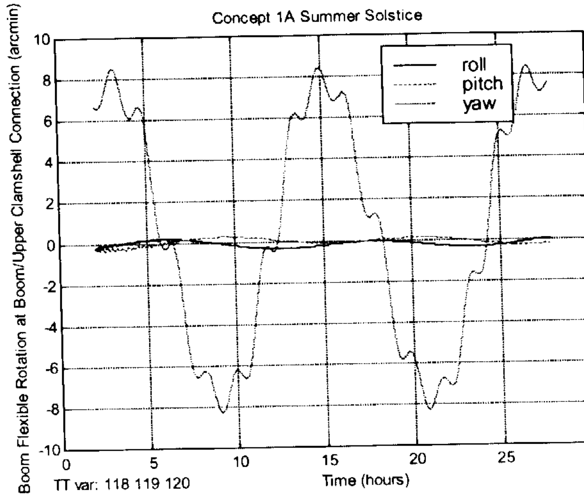


Figure B.1.-11b: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Summer Solstice)

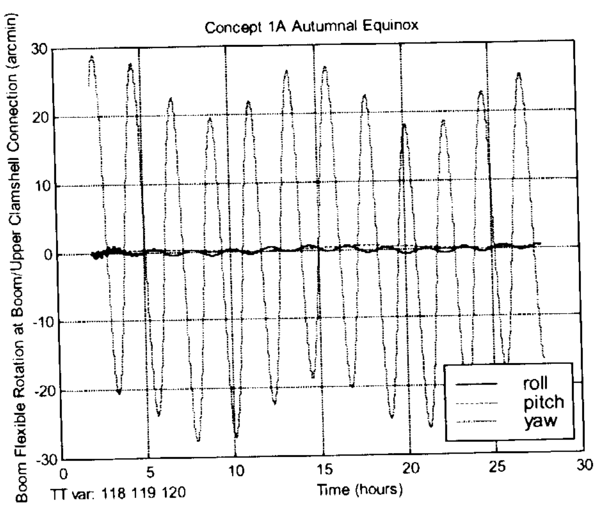


Figure B.1-11c: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Autumnal Equinox)

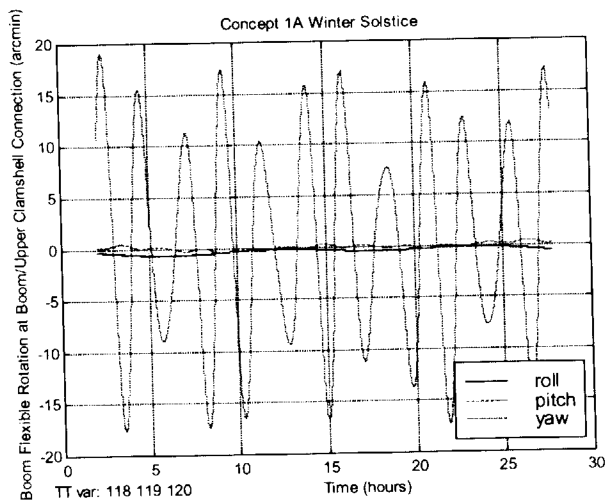


Figure B.1-11d: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Winter Solstice)

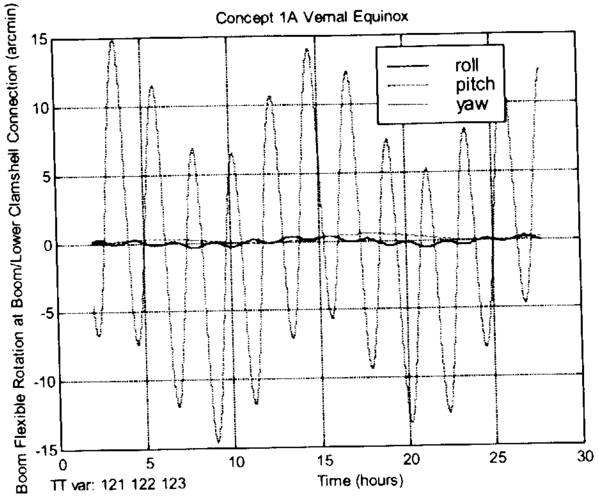


Figure B.1-12a: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

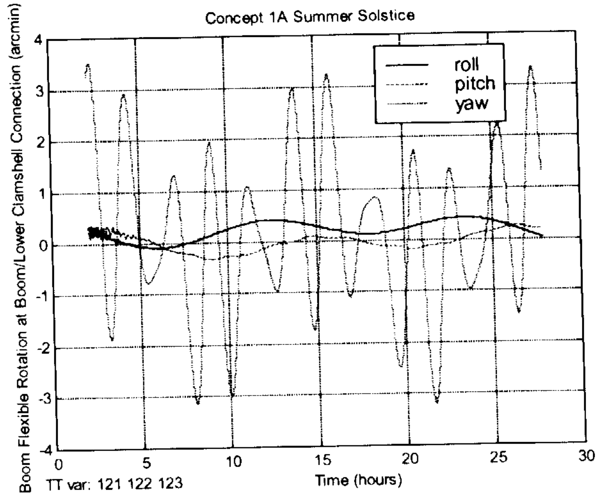


Figure B.1-12b: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Summer Solstice)

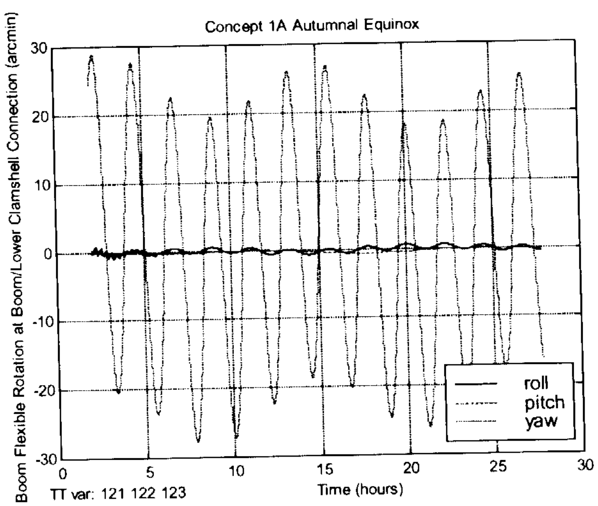


Figure B.1-12c: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Autumnal Equinox)

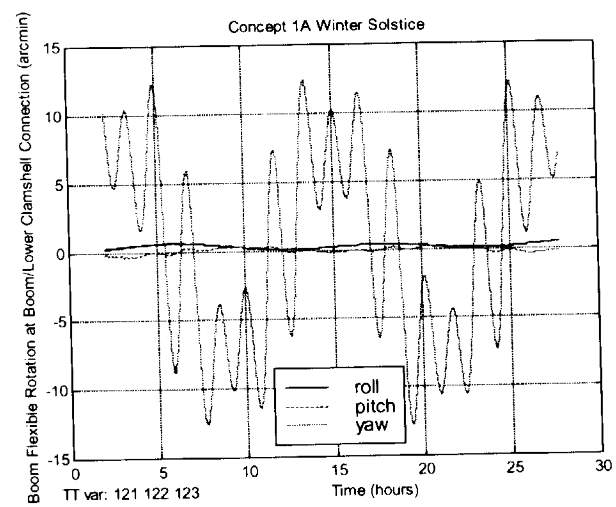


Figure B.1-12d: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Winter Solstice)

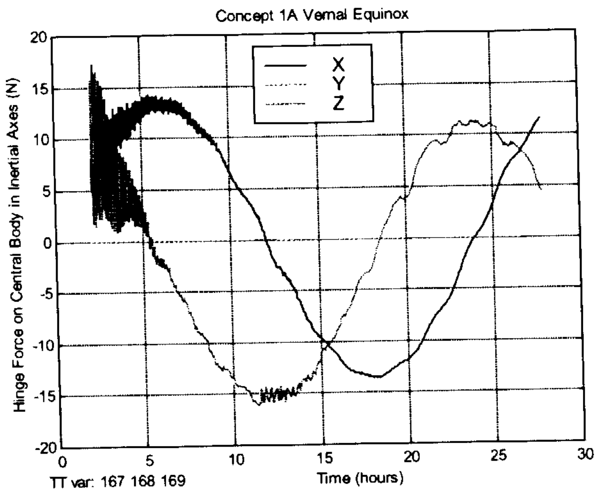


Figure B.1-13a: Hinge Force on Central Body in Inertial Axes vs. Time (Vernal Equinox)

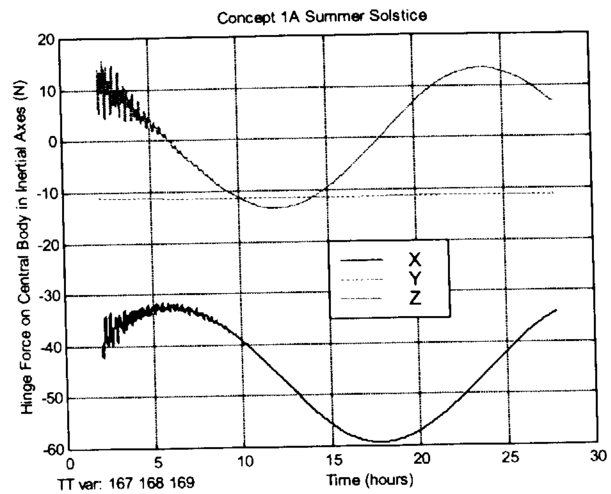


Figure B.1-13b: Hinge Force on Central Body in Inertial Axes vs. Time (Summer Solstice)

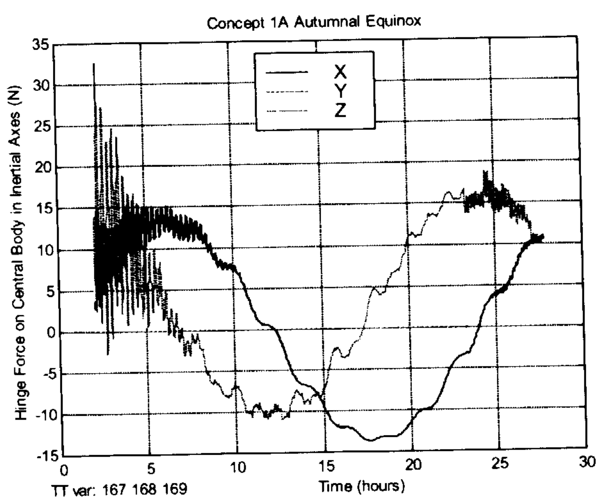


Figure B.1-13c: Hinge Force on Central Body in Inertial Axes vs. Time (Autumnal Equinox)

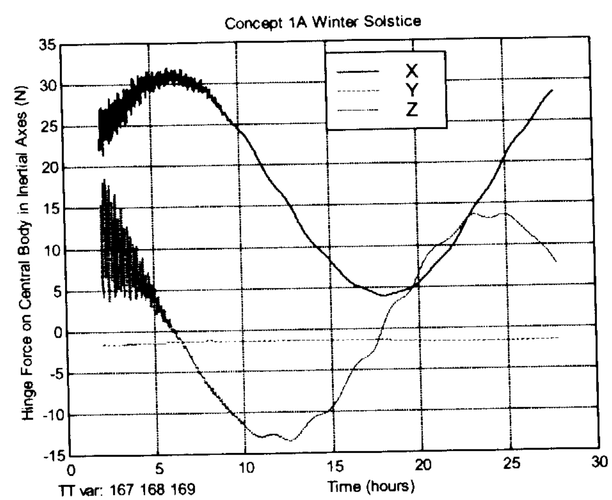


Figure B.1-13d: Hinge Force on Central Body in Inertial Axes vs. Time (Winter Solstice)

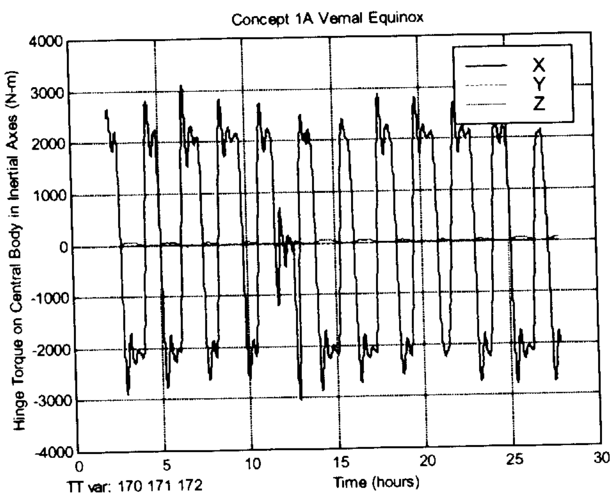


Figure B.1-14a: Hinge Torque on Central Body in Inertial Axes vs. Time (Vernal Equinox)

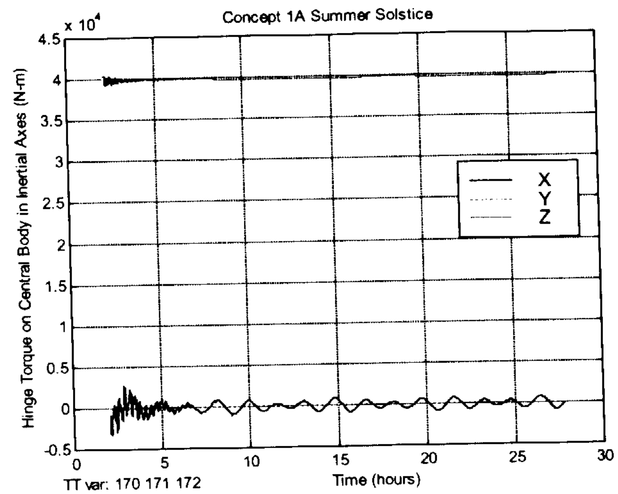


Figure B.1-14b: Hinge Torque on Central Body in Inertial Axes vs. Time (Summer Solstice)

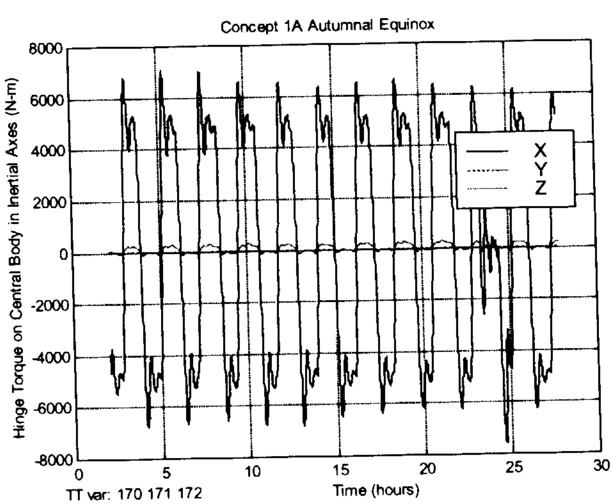


Figure B.1-14c: Hinge Torque on Central Body in Inertial Axes vs. Time (Autumnal Equinox)

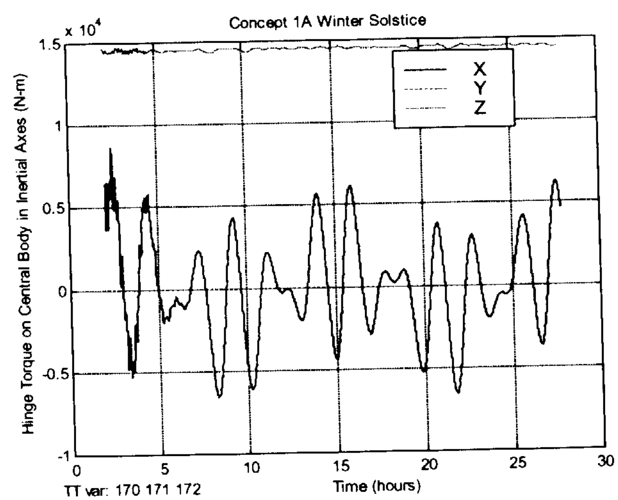


Figure B.1-14d: Hinge Torque on Central Body in Inertial Axes vs. Time (Winter Solstice)

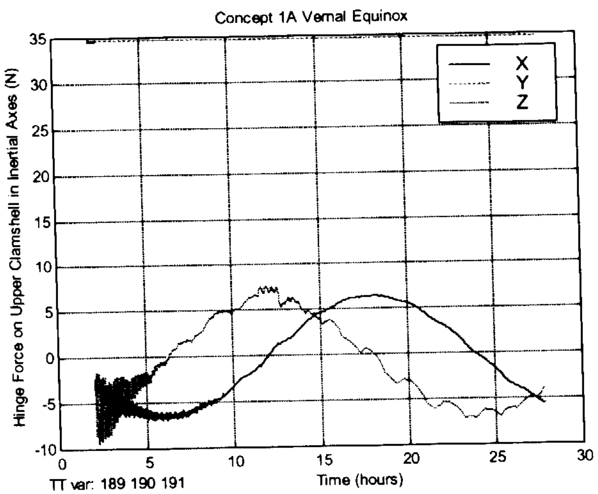


Figure B.1-15a: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Vernal Equinox)

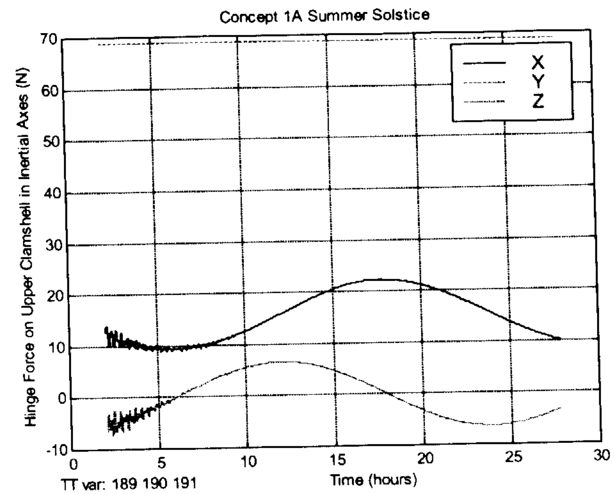


Figure B.1-15b: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Summer Solstice)

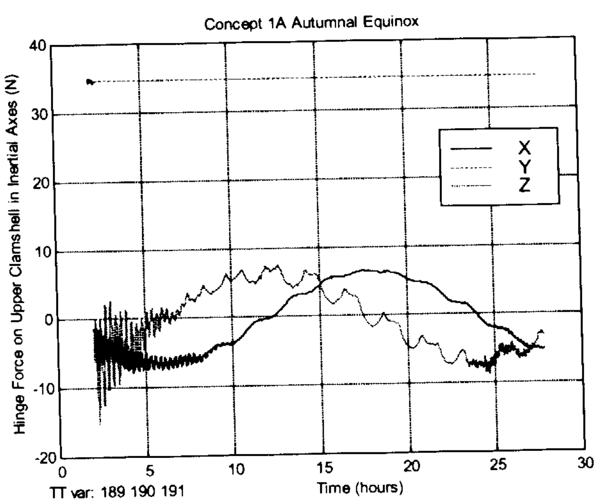


Figure B.1-15c: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Autumnal Equinox)

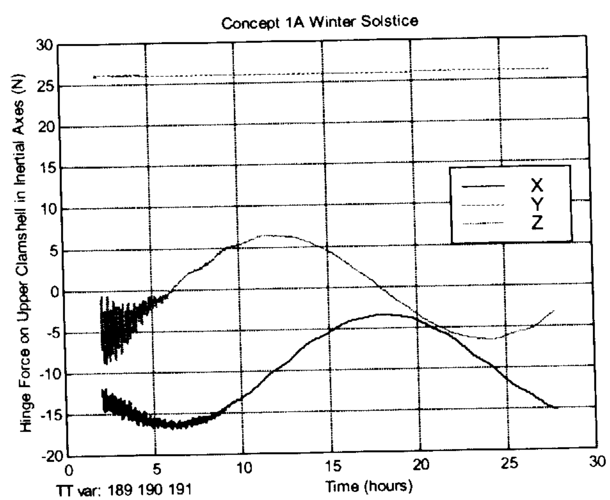


Figure B.1-15d: Hinge Force on Upper clamshell in Inertial Axes vs. Time (Winter Solstice)

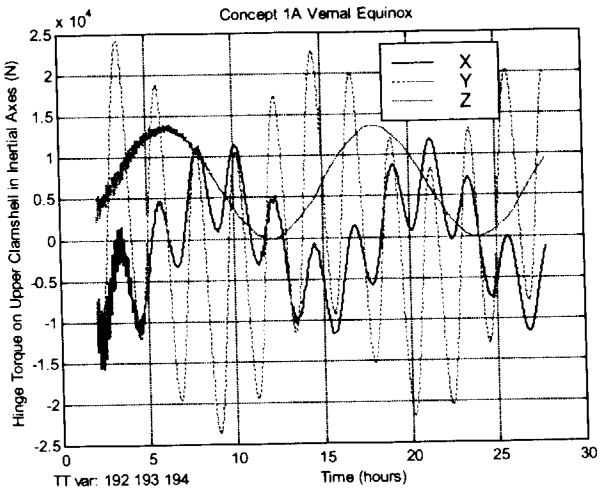


Figure B.1-16a: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Vernal Equinox)

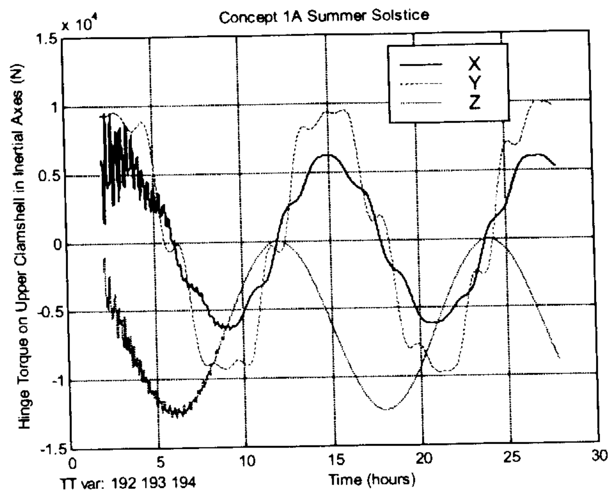


Figure B.1-16b: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Summer Solstice)

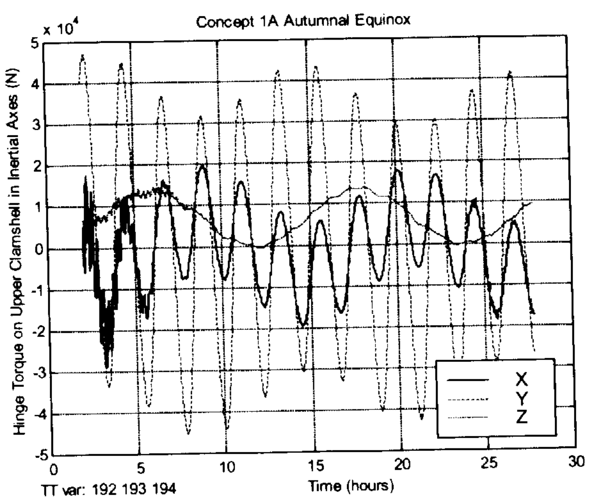


Figure B.1-16c: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Autumnal Equinox)

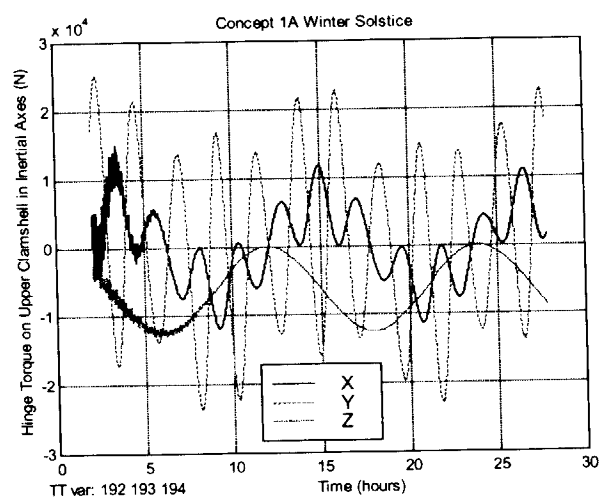


Figure B.1-16d: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Winter Solstice)

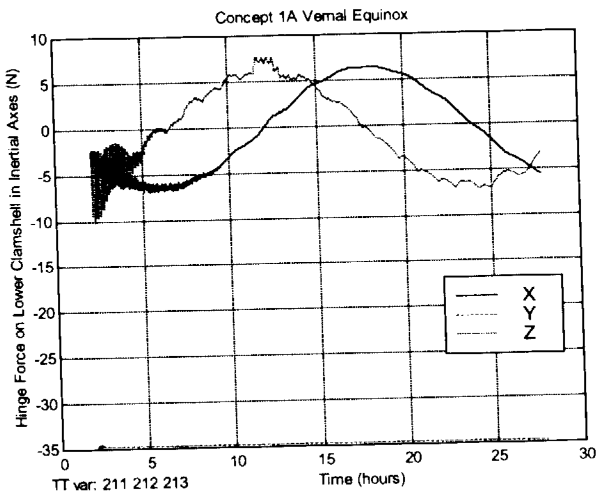


Figure B.1-17a: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

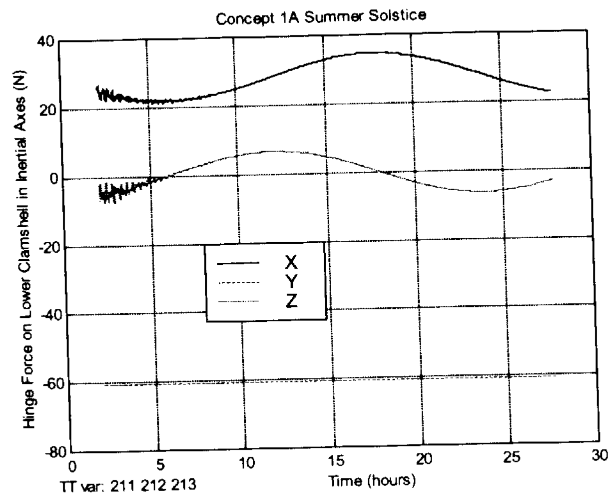


Figure B.1-17b: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Summer Solstice)

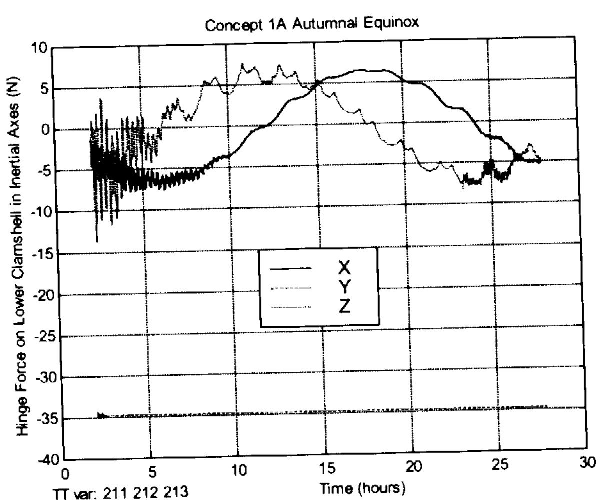


Figure B.1-17c: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Autumnal Equinox)

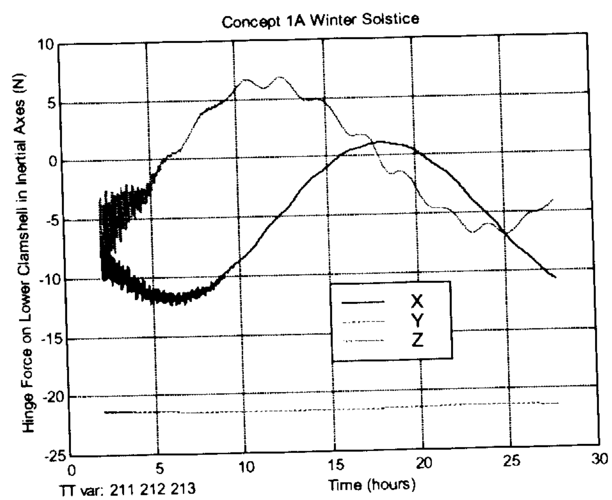


Figure B.1-17d: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Winter Solstice)

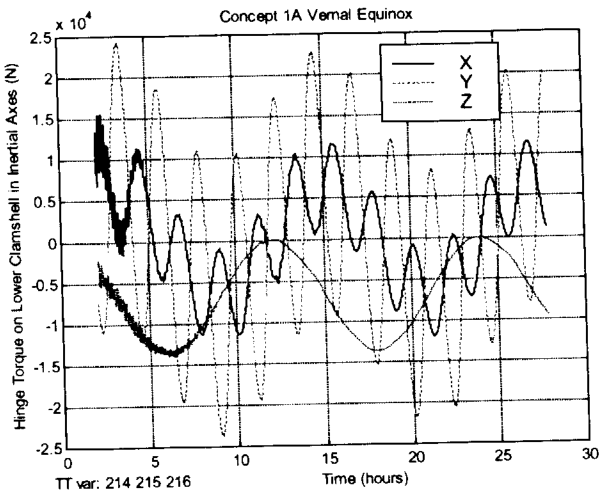


Figure B.1-18a: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Vernal Equinox)

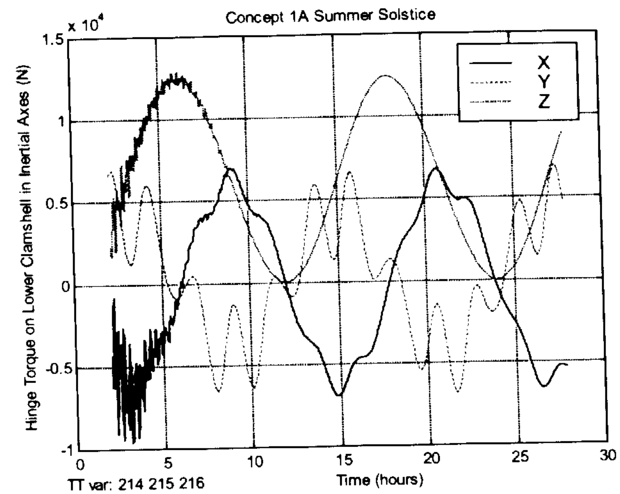


Figure B.1-18b: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Summer Solstice)

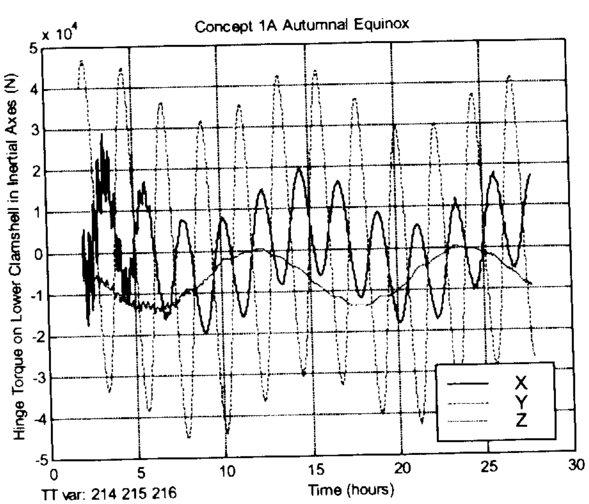


Figure B.1-18c: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Autumnal Equinox)

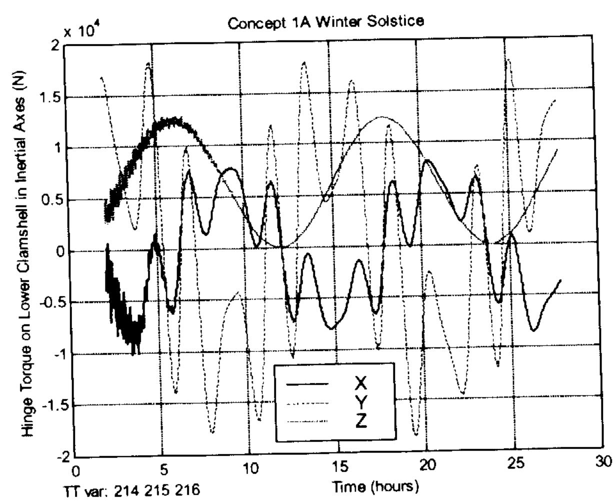


Figure B.1-18d: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Winter Solstice)

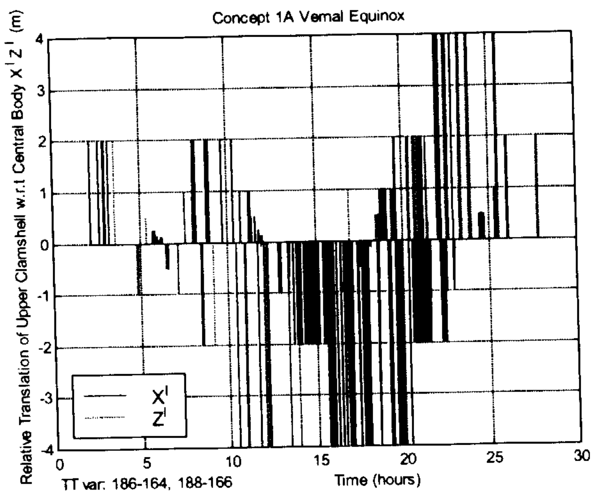


Figure B.1-19a: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

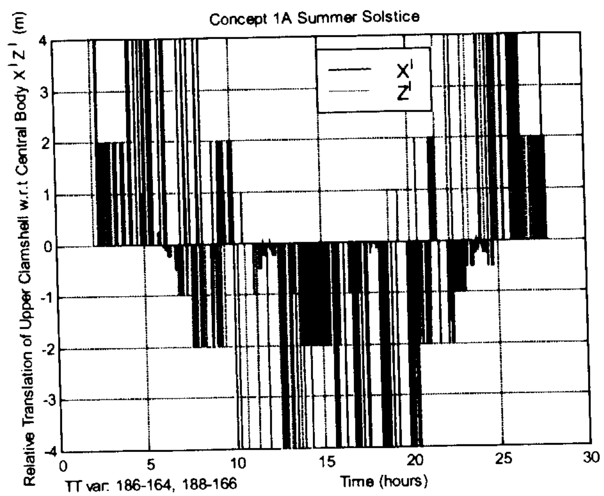


Figure B.1-19b: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Summer Solstice)

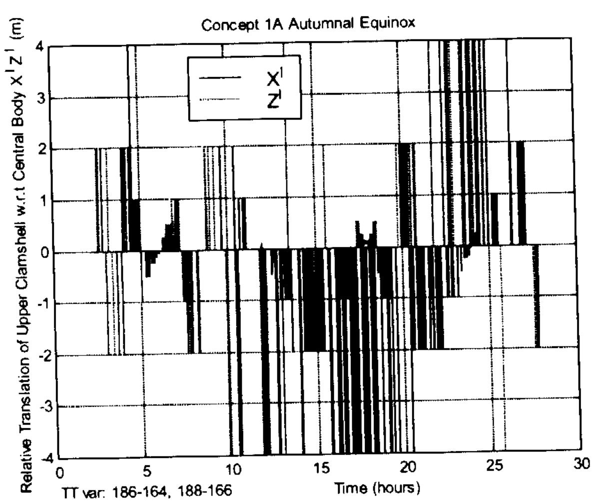


Figure B.1-19c: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Autumnal Equinox)

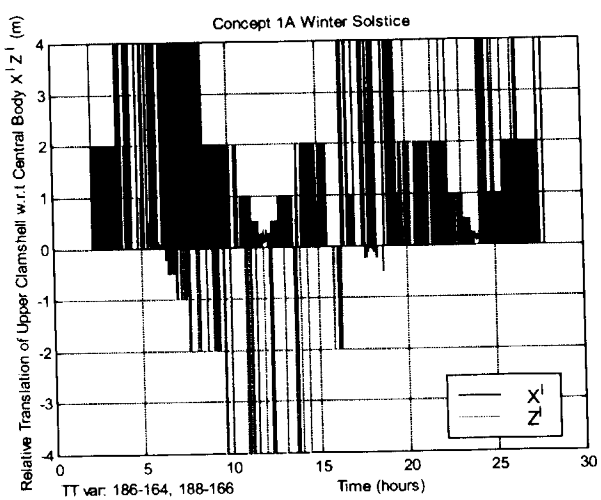


Figure B.1-19d: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Winter Solstice)

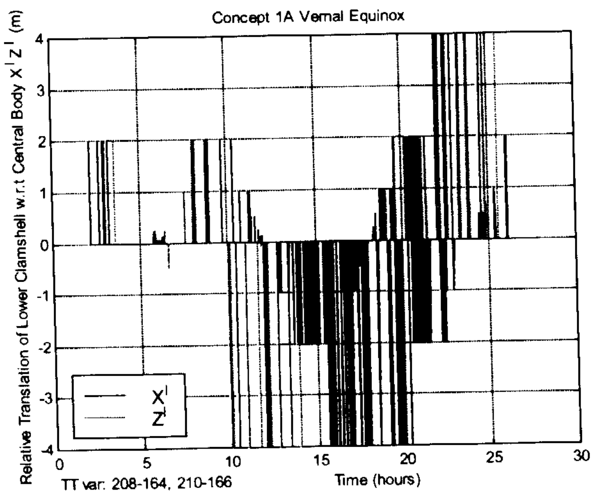


Figure B.1-20a: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

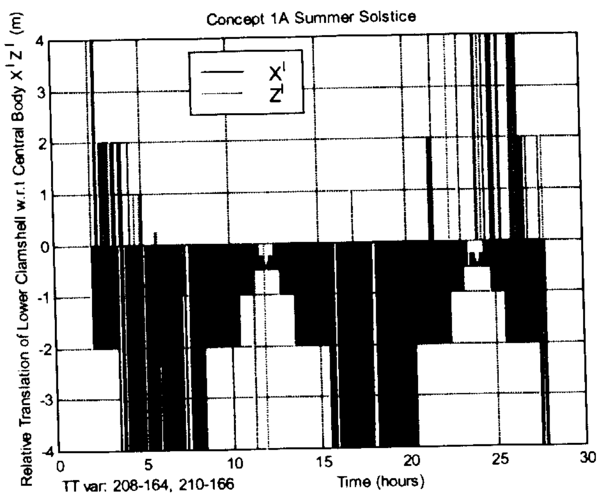


Figure B.1-20b: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Summer Solstice)

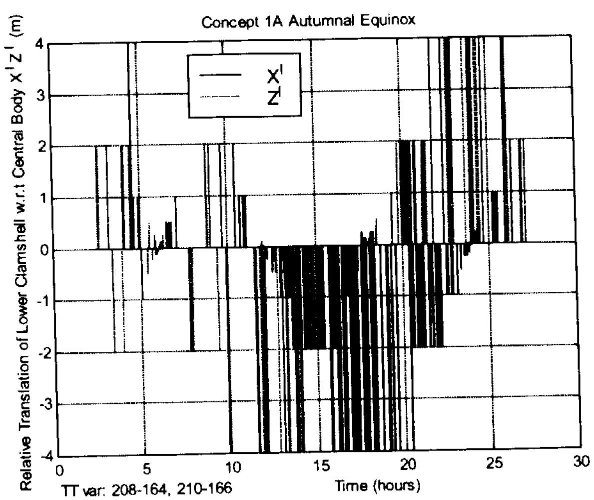


Figure B.1-20c: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Autumnal Equinox)

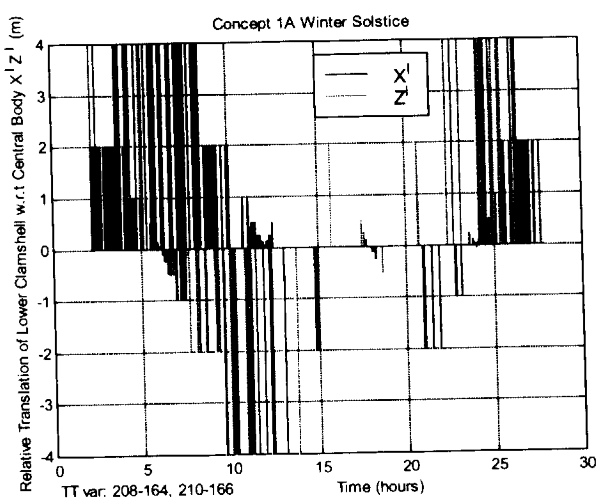


Figure B.1-20d: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Winter Solstice)

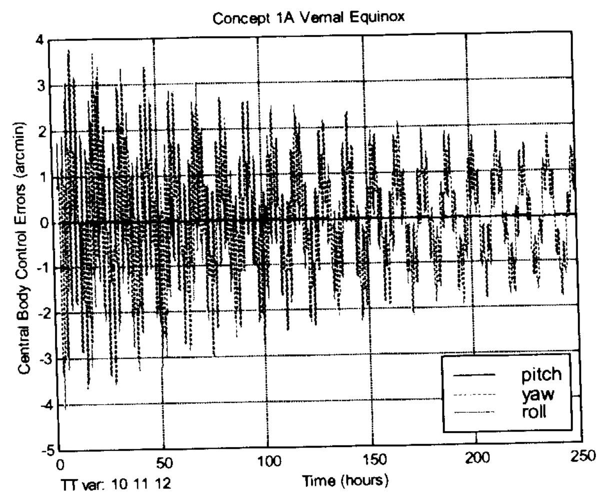


Figure B.1-21: Central Body Control Errors vs. Time (Vernal Equinox)

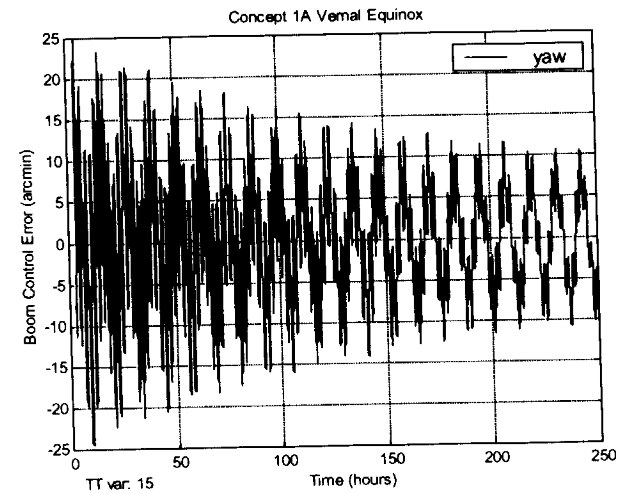


Figure B.1-22: Boom Control Errors vs. Time (Vernal Equinox)

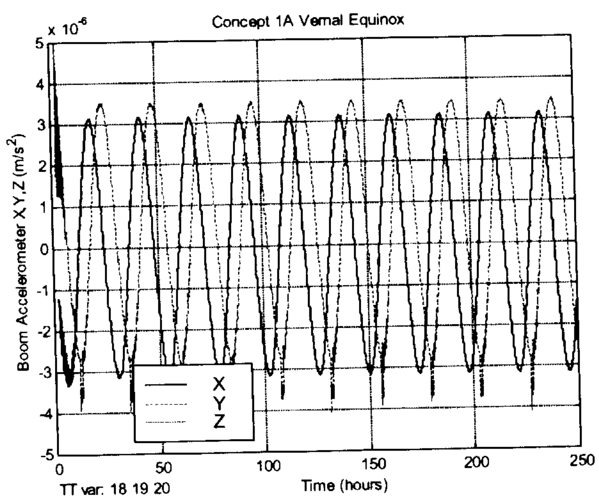


Figure B.1-23: Boom Accelerometer vs. Time (Vernal Equinox)

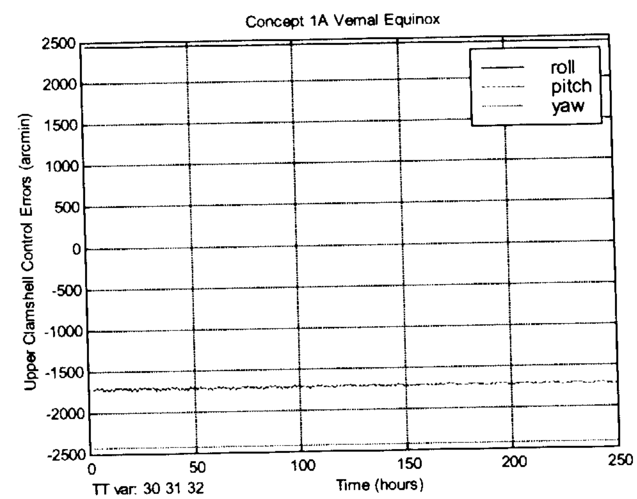


Figure B.1-24: Upper Clamshell Control Errors vs. Time (Vernal Equinox)

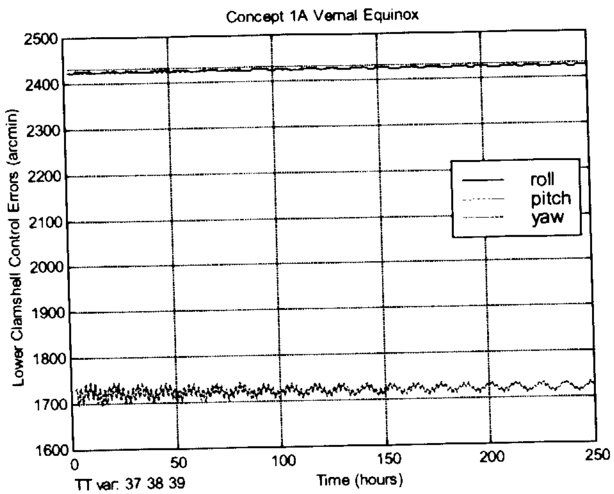


Figure B.1-25: Lower Clamshell Control Errors vs. Time (Vernal Equinox)

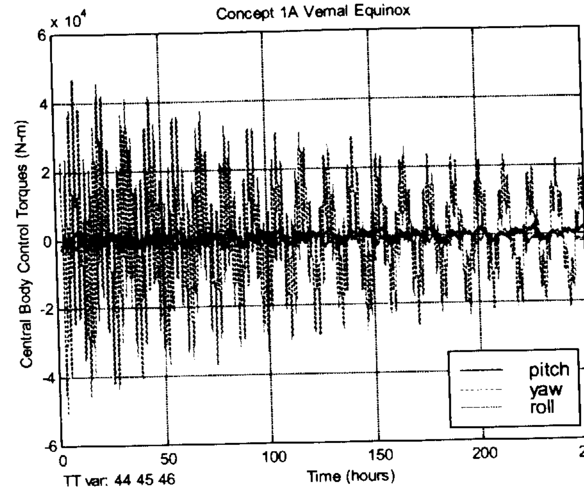


Figure B.1-26: Central Body Control Torques vs. Time (Vernal Equinox)

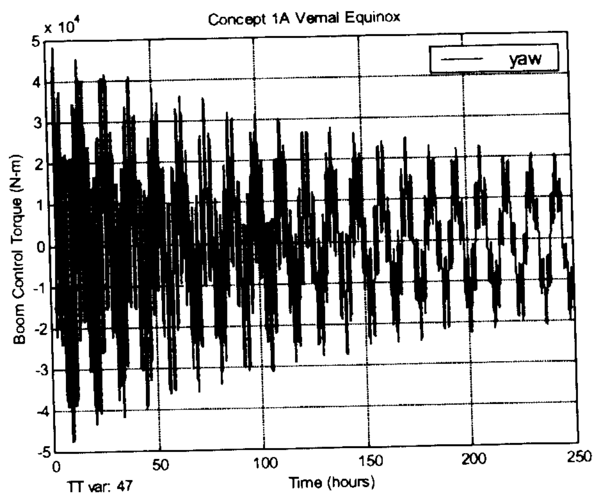


Figure B.1-27: Boom Control Torques vs. Time (Vernal Equinox)

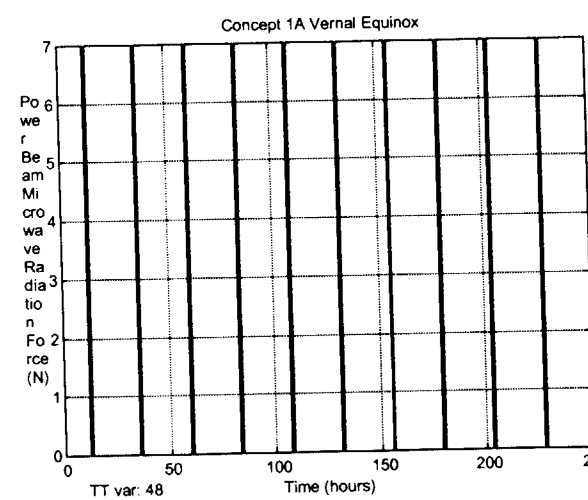


Figure B.1-28: Power Beam Microwave Radiation Force vs. Time (Vernal Equinox)

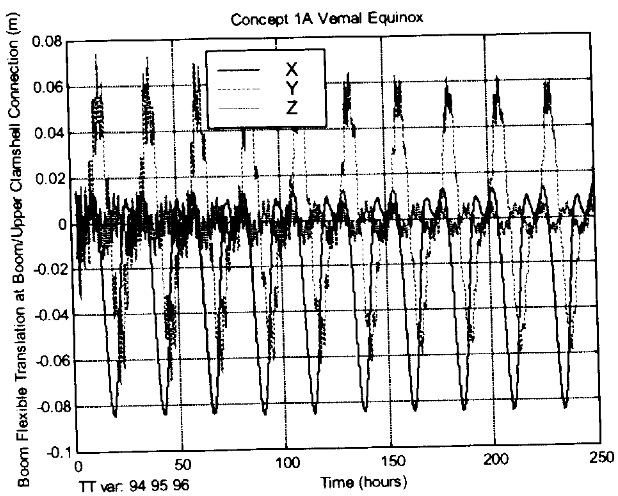


Figure B.1-29: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

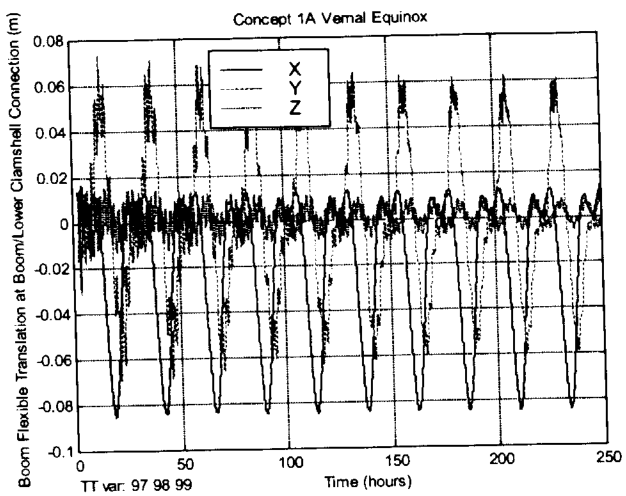


Figure B.1-30: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

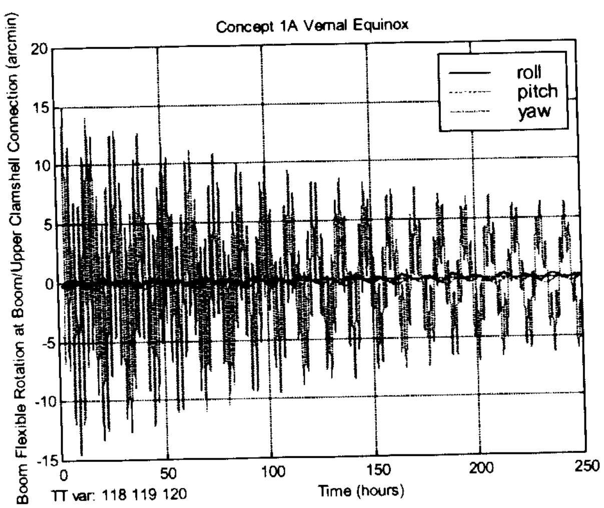


Figure B.1-31: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

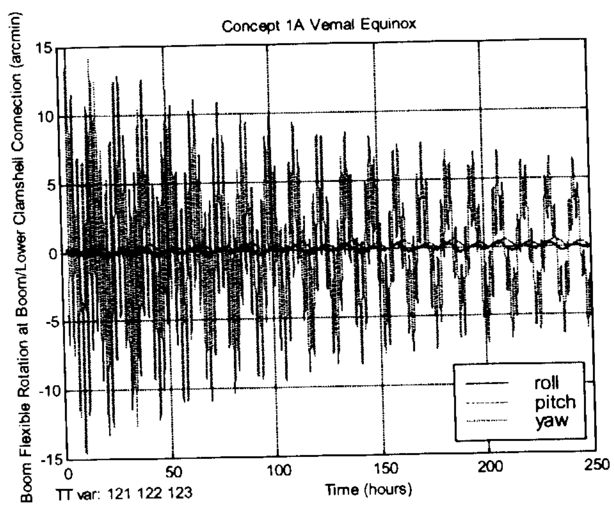


Figure B.1-32: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

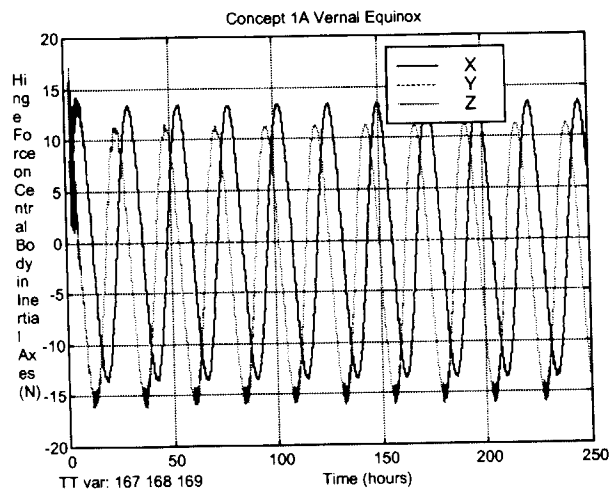


Figure B.1-33: Hinge Force on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

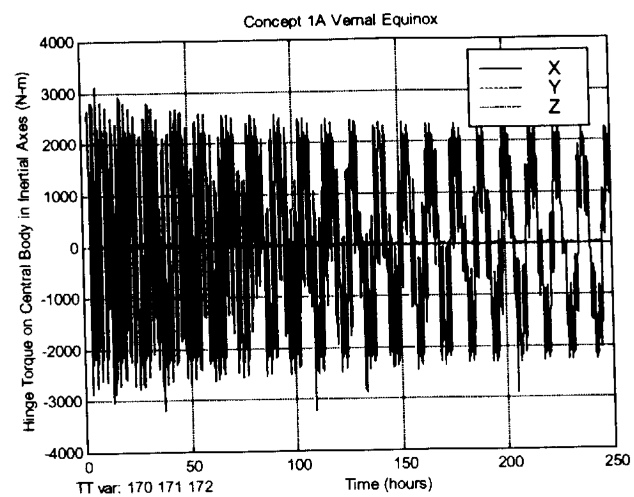


Figure B.1-34: Hinge Torque on Central Body
in Inertial Axes vs. Time
(Vernal Equinox)

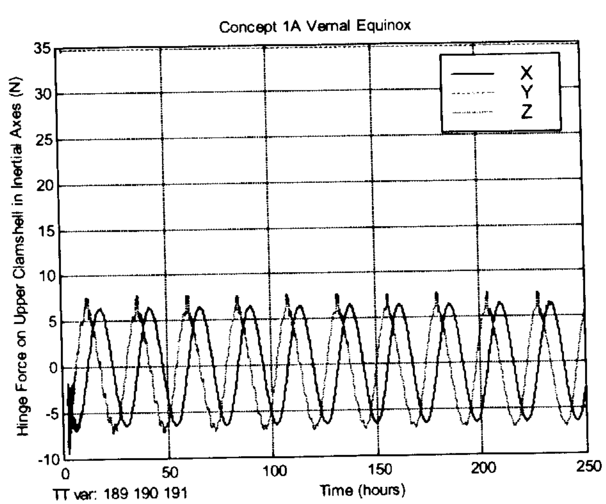


Figure B.1-35: Hinge Force on Upper Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

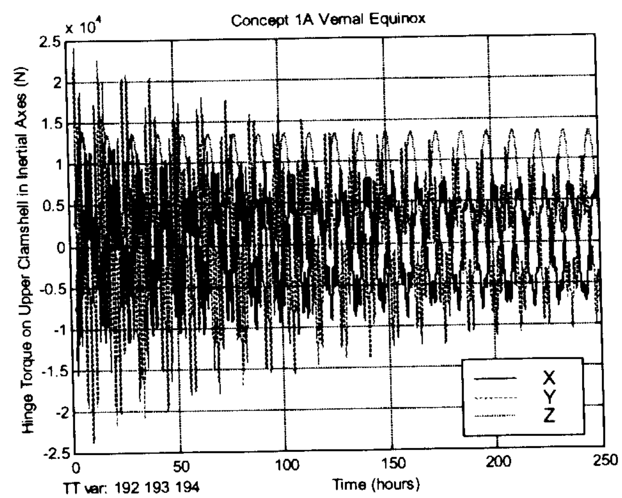


Figure B.1-36: Hinge Torque on Upper Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

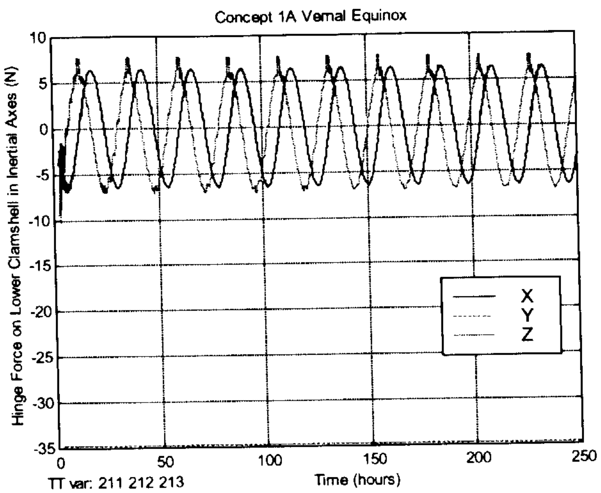


Figure B.1-37: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Vernal Equinox)

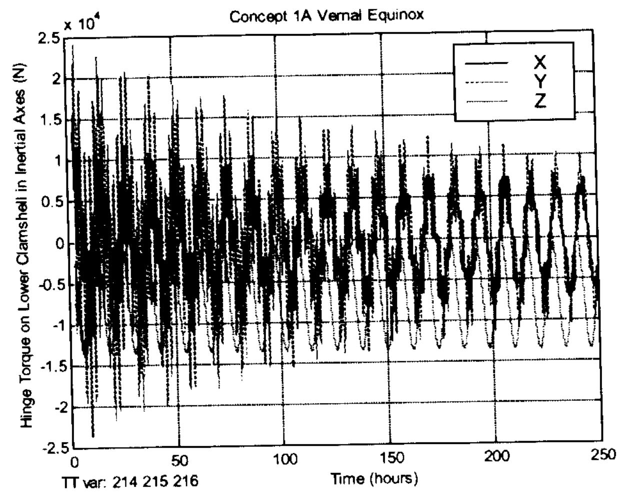


Figure B.1-38: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Vernal Equinox)

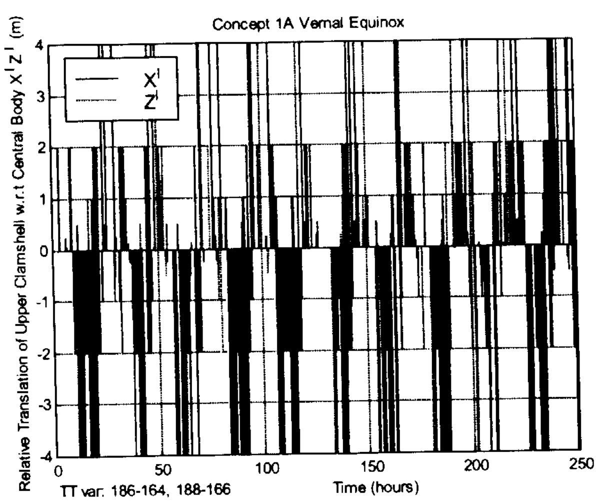


Figure B.1-39: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

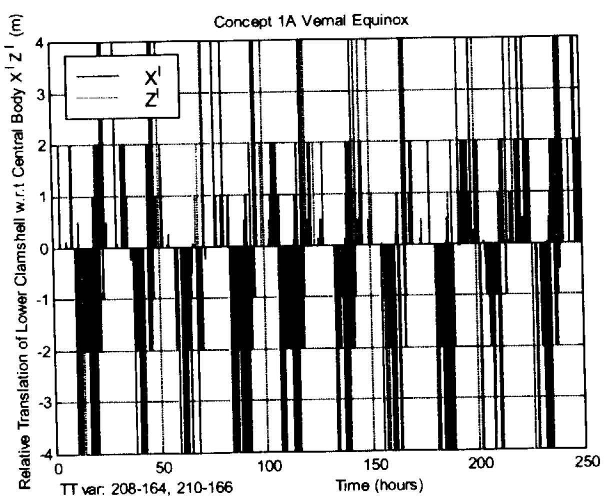


Figure B.1-40: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

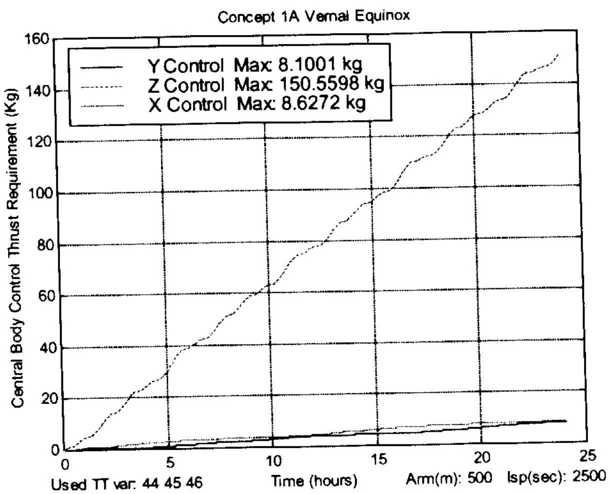


Figure B.1-41a: Central Body Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

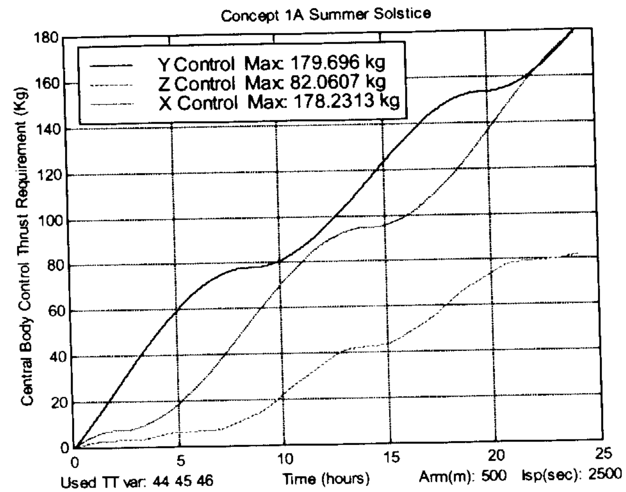


Figure B.1-41a: Central Body Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

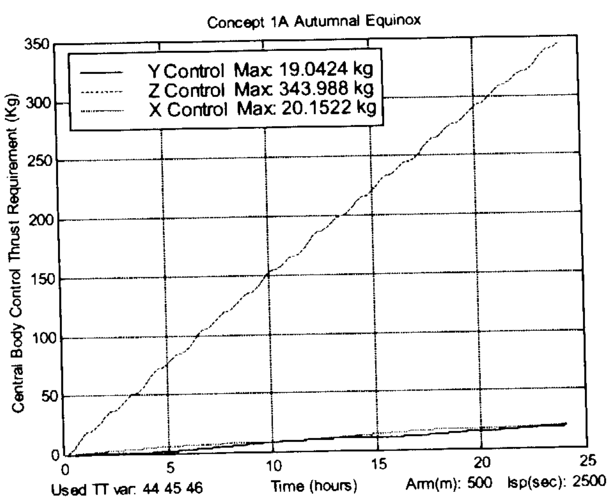


Figure B.1-41c: Central Body Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

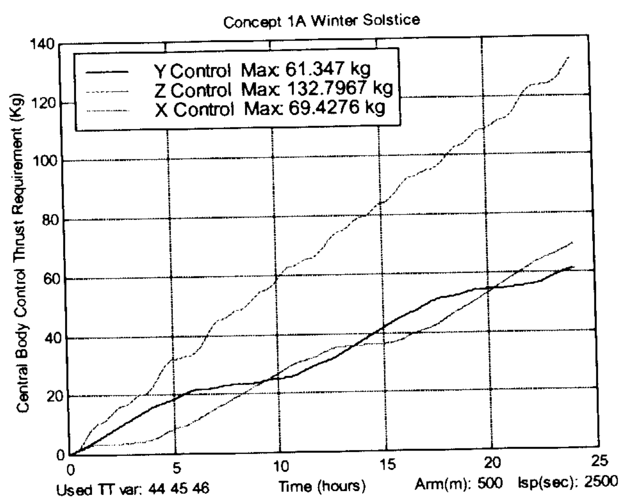


Figure B.1-41d: Central Body Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

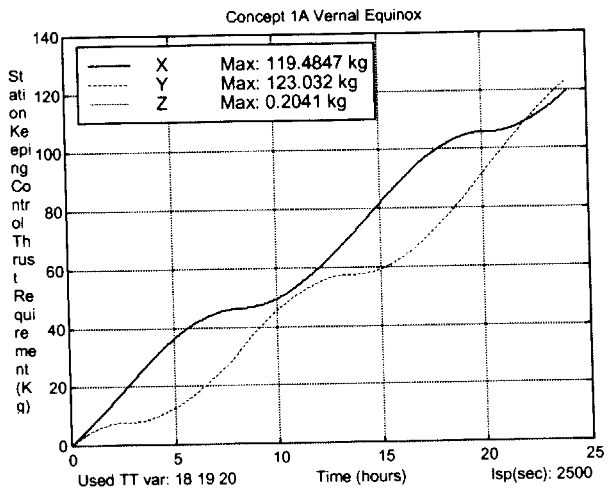


Figure B.1-42a: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

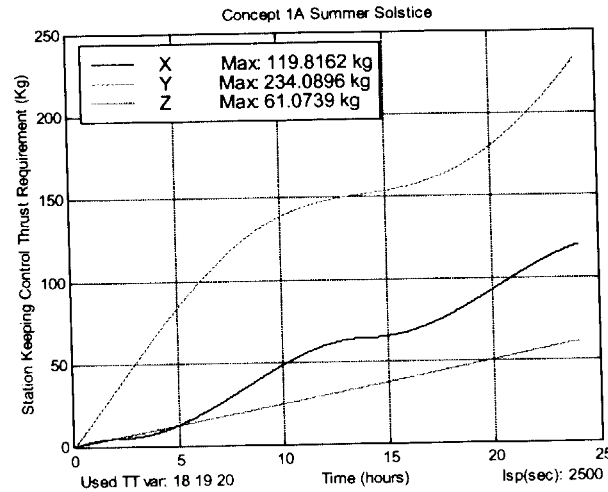


Figure B.1-42b: Station Keeping Clamshell Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

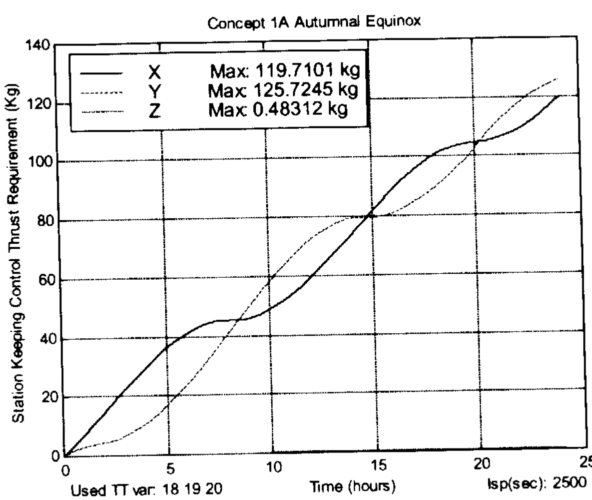


Figure B.1-42c: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

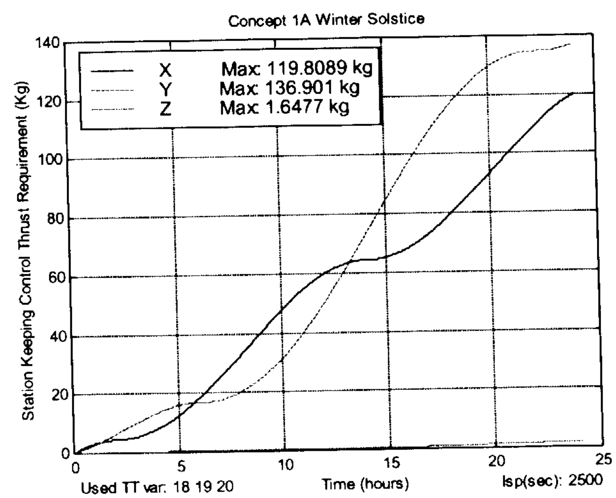


Figure B.1-42d: Station Keeping Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

Table B.1-1: Predicted Daily Thrust Requirements (Kg) (Concept 1) (Now Obsolete, See Table B.1-5)

	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			
Description	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	Total
Central Body Control	~~8.627~~	~~8.100~~	~~150.560~~	178.231	179.696	82.061	~~20.152~~	~~19.042~~	~~343.988~~	~~60.428~~	~~61.347~~	~~132.707~~	~~60.110~~	~~67.046~~	~~177.352~~	~~313.508~~

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m
2) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

Table B.1-2: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 1) (Now Obsolete, See Table B.1-6)

	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			
Description	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	Total
Station Keeping Control	~~119.485~~	~~123.032~~	~~.204~~	119.816	234.090	61.074	~~119.710~~	~~125.725~~	~~.483~~	~~119.809~~	~~136.001~~	~~1.648~~	~~119.705~~	~~154.937~~	~~15.852~~	~~290.494~~

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

TABLE B.1-3: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 1) (Now Obsolete, See Table B.1-7)

	Daily Total				Yearly Total			
Description	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control	Total (1 Year)
Central Body Control	~~69.110~~	~~67.046~~	~~177.352~~	~~313.508~~	~~25242.~~	~~24489.~~	~~64779.~~	~~114510.~~

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m
2) 1 Year = 365.25 days
3) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

TABLE B.1-4: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 1) (Now Obsolete, See Table B.1-8)

	Daily Total				Yearly Total			
Description	X	Y	Z	Total (1 Day)	X	Y	Z	Total (1 Year)
Station Keeping Control	~~119.705~~	~~154.937~~	~~15.852~~	~~290.494~~	~~43722.~~	~~56591.~~	~~5790.~~	~~106103.~~

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) 1 Year = 365.25 days
3) In reference to crossed-out numbers above, it was later determined that the initial condition for Concept 1 L1(Z^B) should have been 90 deg for all cases.

Table B.1-5: Predicted Daily Thrust Requirements (Kg) (Concept 1)

	Vernal Equinox (est.)			Summer Solstice (calc.)			Autumnal Equinox (est.)			Winter Solstice (est.)			Daily Average			Total
Description	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.89	2.88	90.5	178.231	179.696	82.061	5.53	5.31	90.6	178.2	179.5	82.04	91.463	91.847	86.300	269.610

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m
2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.

Table B.1-6: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 1)

	Vernal Equinox (est.)			Summer Solstice (calc.)			Autumnal Equinox (est.)			Winter Solstice (est.)			Daily Average			Total
Description	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	130.2	258.5	.762	119.816	234.090	61.074	139.4	258.9	1.778	120.2	234.11	61.074	127.404	246.400	31.172	404.976

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.

TABLE B.1-7: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 1)

	Daily Total				Yearly Total			
Description	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control	Total (1 Year)
Central Body Control	91.463	91.847	86.300	269.610	33407.	33547.	31521.	98475.

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m
2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.
3) 1 Year = 365.25 days

TABLE B.1-8: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 1)

	Daily Total				Yearly Total			
Description	X	Y	Z	Total (1 Day)	X	Y	Z	Total (1 Year)
Station Keeping Control	127.404	246.400	31.172	404.976	46534.	89998.	11386.	147918.

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) Est. = Estimated using (Summer Solstice calc 1/Summer Solstice calc 3)x(calc 3) for each case and component.
3) 1 Year = 365.25 days

B.2 - TREETOPS simulation results and Thrust Requirements for Concept 3

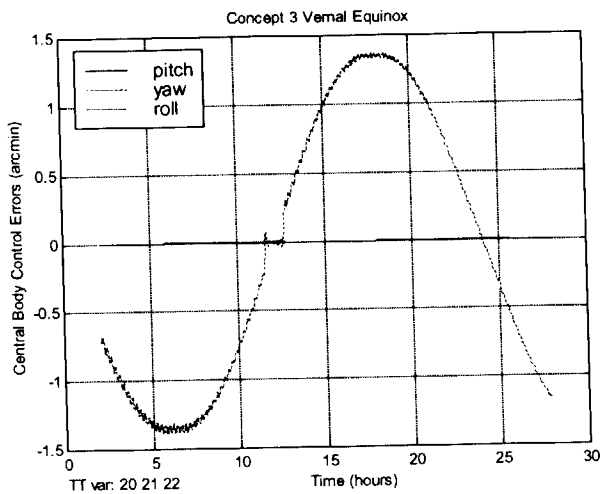


Figure B.2-1a: Central Body Control Errors vs. Time (Vernal Equinox)

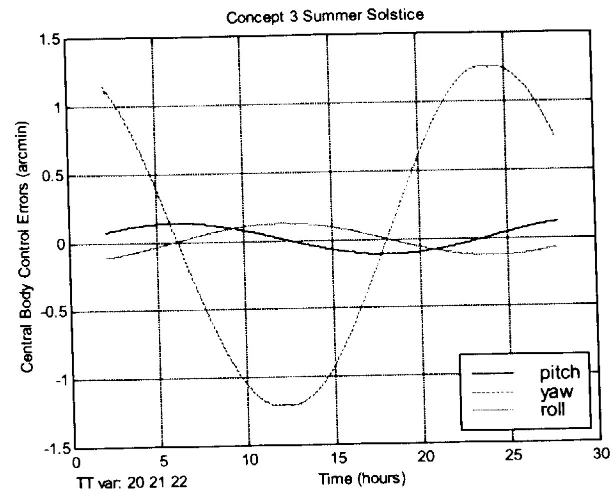


Figure B.2-1b: Central Body Control Errors vs. Time (Summer Solstice)

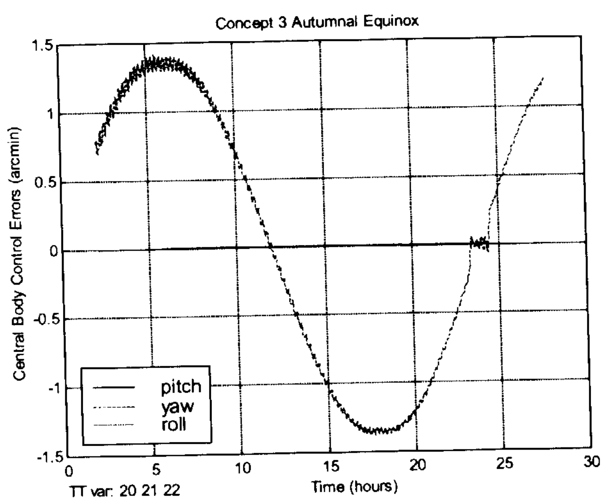


Figure B.2-1c: Central Body Control Errors vs. Time (Autumnal Equinox)

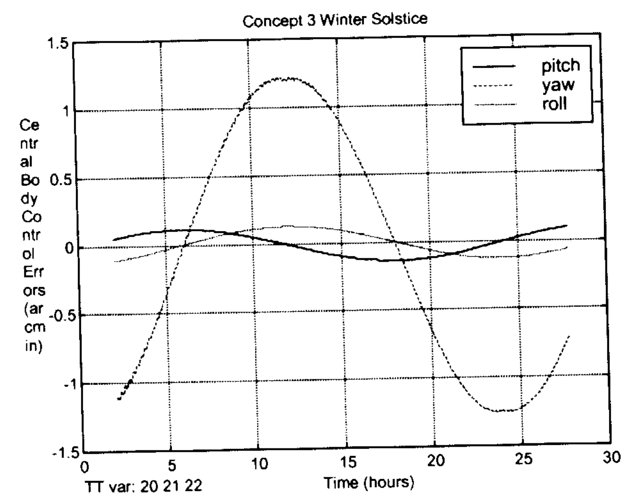


Figure B.2-1d: Central Body Control Errors vs. Time (Winter Solstice)

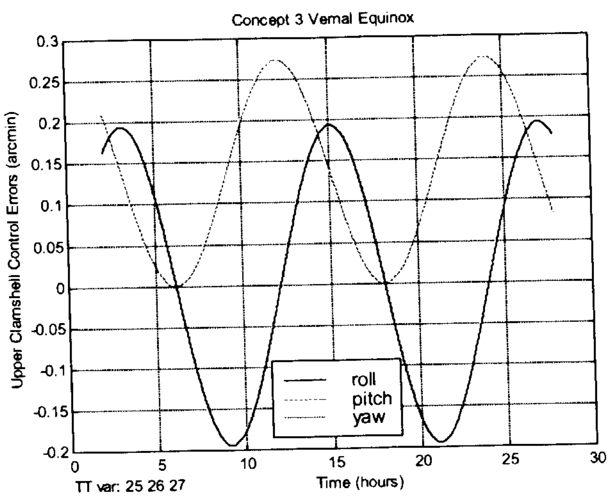


Figure B.2-2a: Upper Clamshell Control Errors vs. Time
(Vernal Equinox)

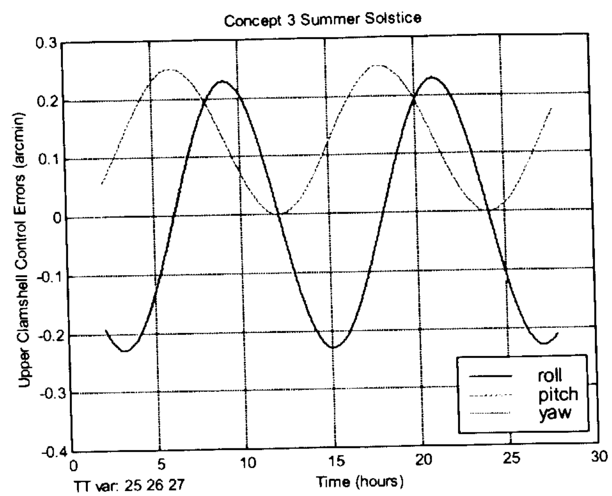


Figure B.2-2b: Upper Clamshell Control Errors vs. Time
(Summer Solstice)

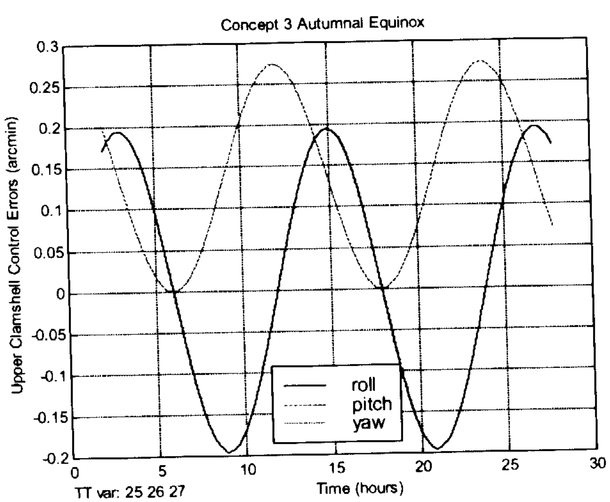


Figure B.2-2c: Upper Clamshell Control Errors vs. Time
(Autumnal Equinox)

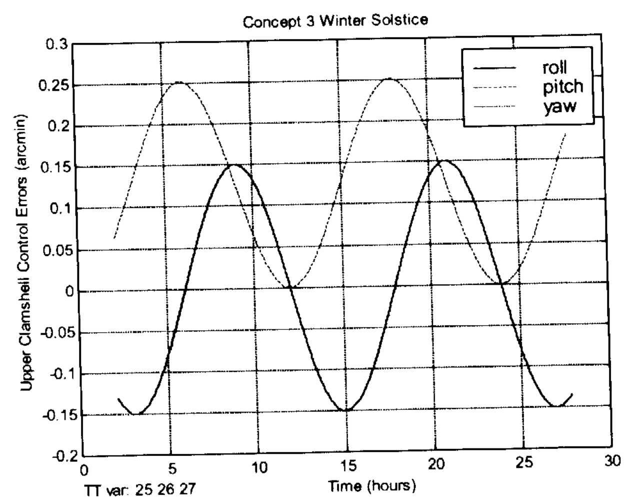


Figure B.2-2d: Upper Clamshell Control Errors vs. Time
(Winter Solstice)

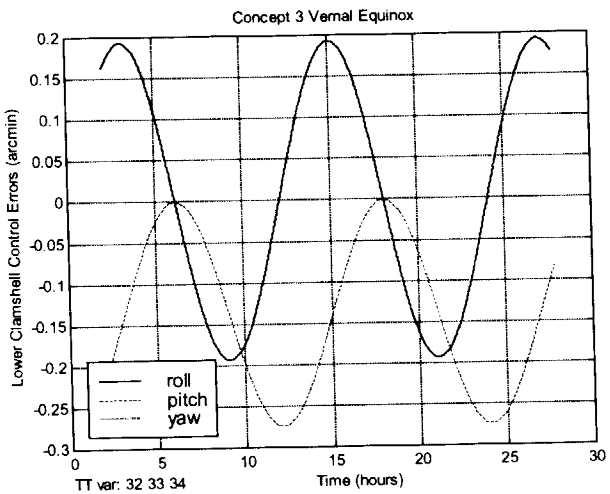


Figure B.2-3a: Lower Clamshell Control Errors vs. Time (Vernal Equinox)

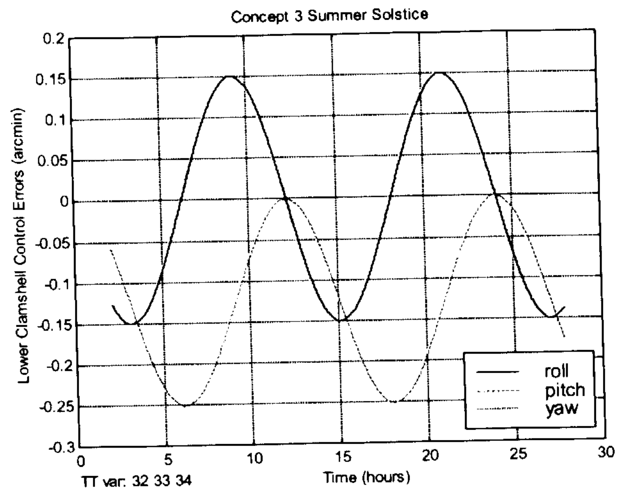


Figure B.2-3b: Lower Clamshell Control Errors vs. Time (Summer Solstice)

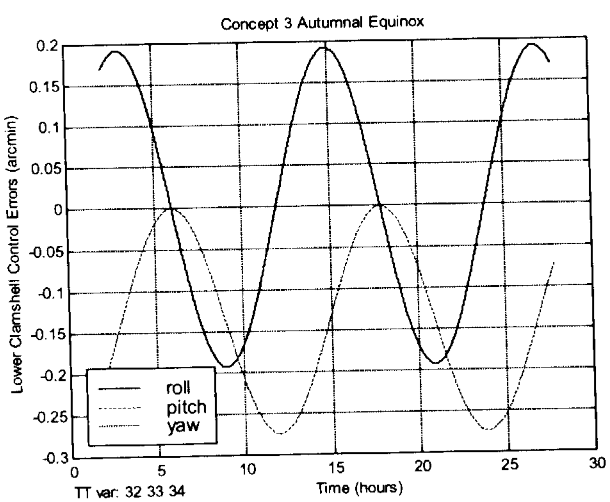


Figure B.2-3c: Lower Clamshell Control Errors vs. Time (Autumnal Equinox)

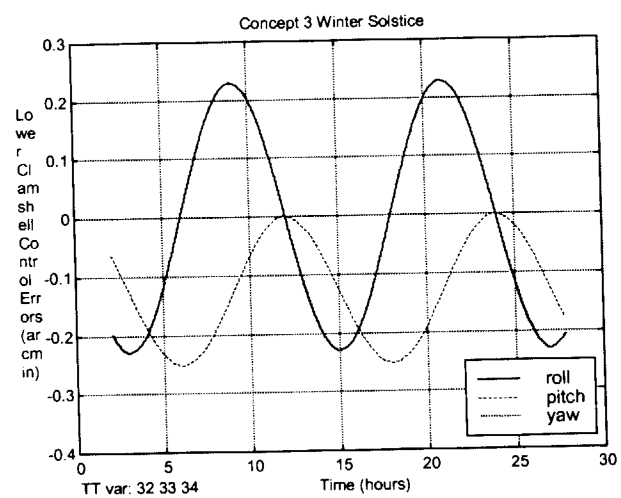


Figure B.2-3d: Lower Clamshell Control Errors vs. Time (Winter Solstice)

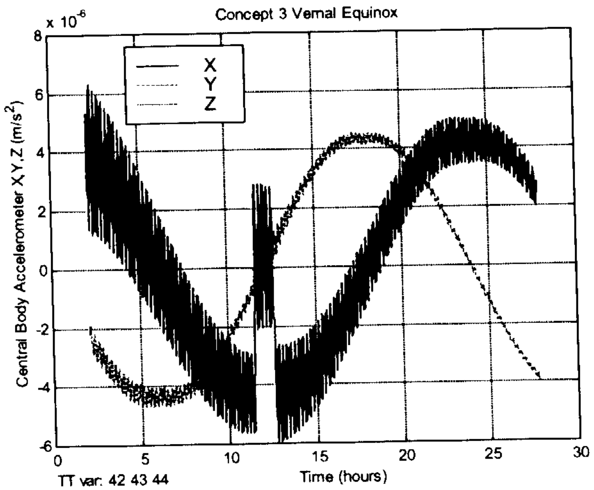


Figure B.2-4a: Central Body Accelerometer vs. Time (Vernal Equinox)

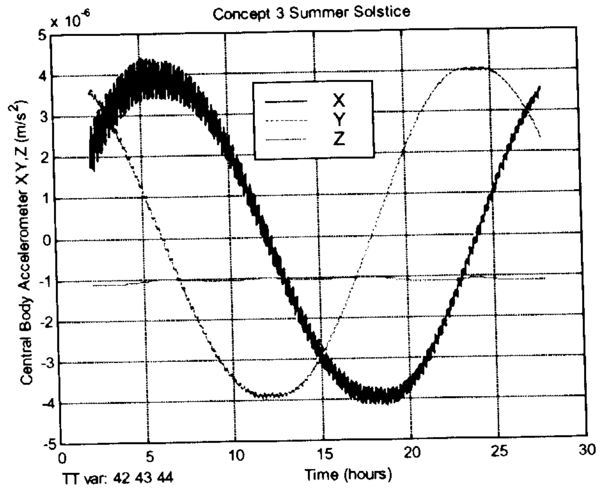


Figure B.2-4b: Central Body Accelerometer vs. Time (Summer Solstice)

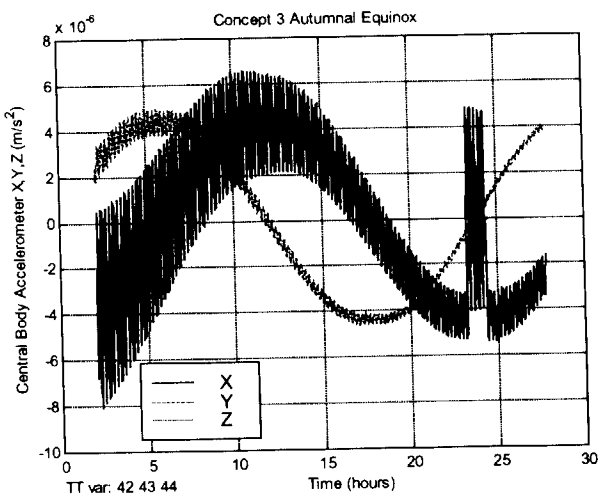


Figure B.2-4c: Central Body Accelerometer vs. Time (Autumnal Equinox)

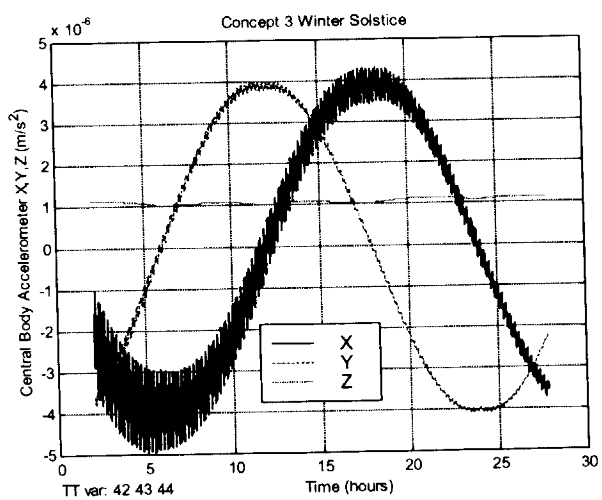


Figure B.2-4d: Central Body Accelerometer vs. Time (Winter Solstice)

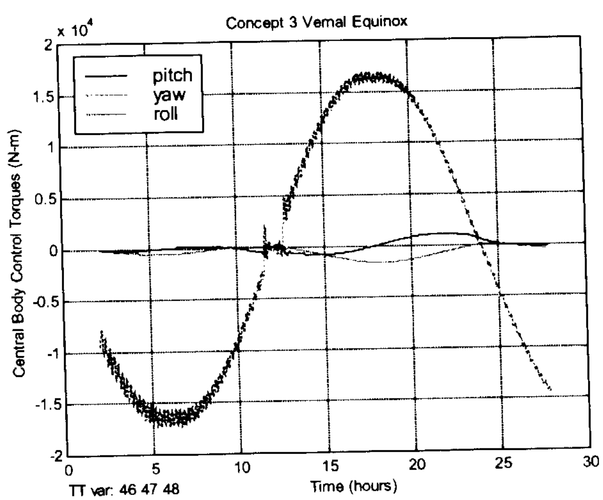


Figure B.2-5a: Central Body Control Torques vs. Time (Vernal Equinox)

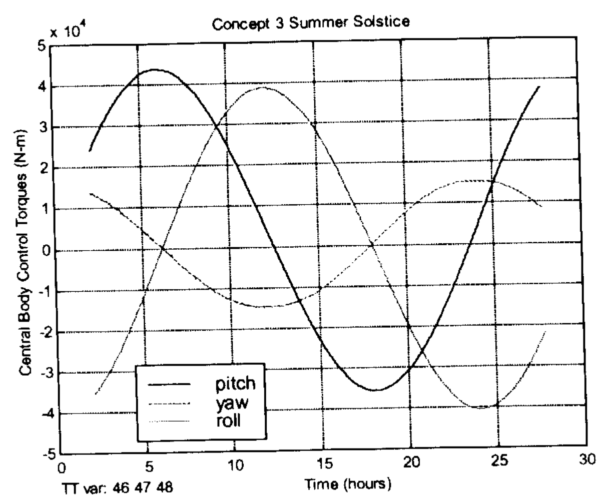


Figure B.2-5b: Central Body Control Torques vs. Time (Summer Solstice)

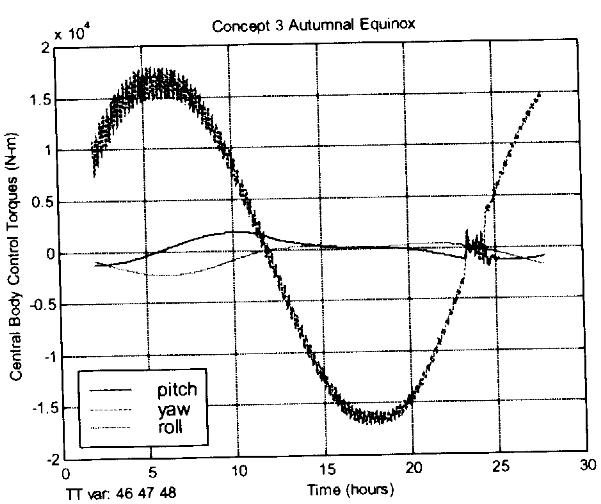


Figure B.2-5c: Central Body Control Torques vs. Time (Autumnal Equinox)

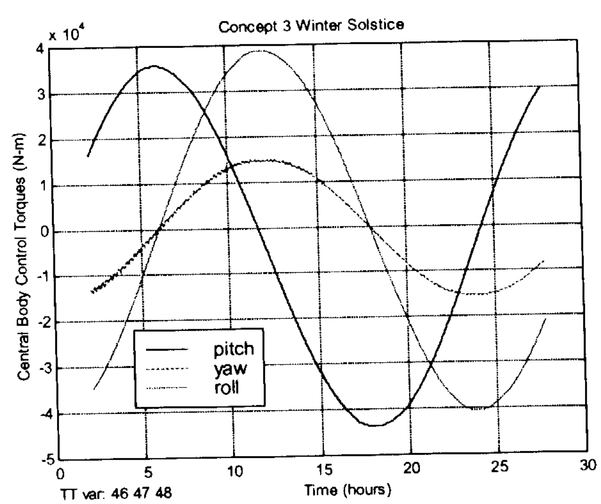


Figure B.2-5d: Central Body Control Torques vs. Time (Winter Solstice)

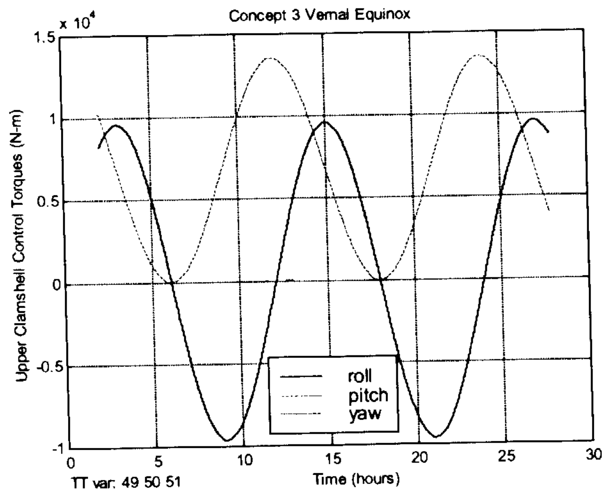


Figure B.2-6a: Upper Clamshell Control Torques vs. Time
(Vernal Equinox)

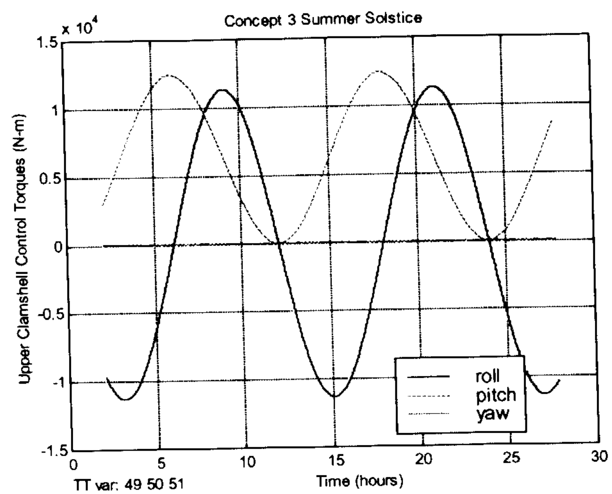


Figure B.2-6b: Upper Clamshell Control Torques vs. Time
(Summer Solstice)

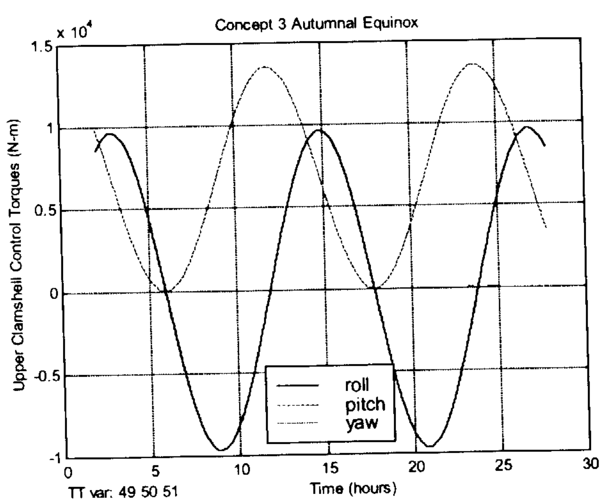


Figure B.2-6c: Upper Clamshell Control Torques vs. Time
(Autumnal Equinox)

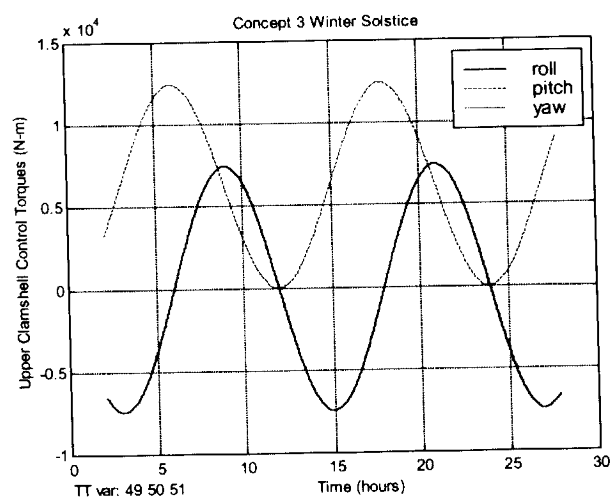


Figure B.2-6d: Upper Clamshell Control Torques vs. Time
(Winter Solstice)

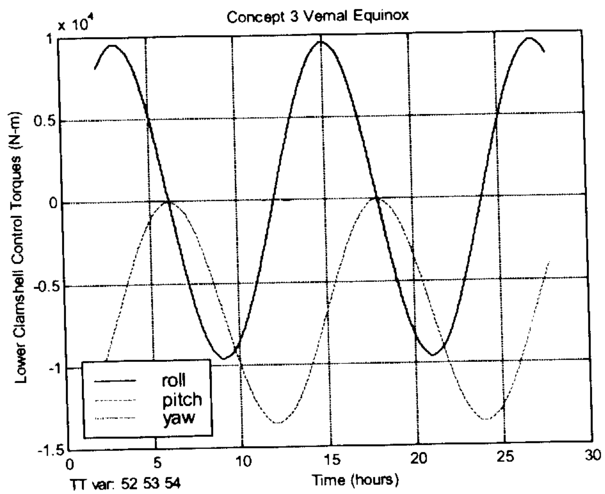


Figure B.2-7a: Lower Clamshell Control Torques vs. Time (Vernal Equinox)

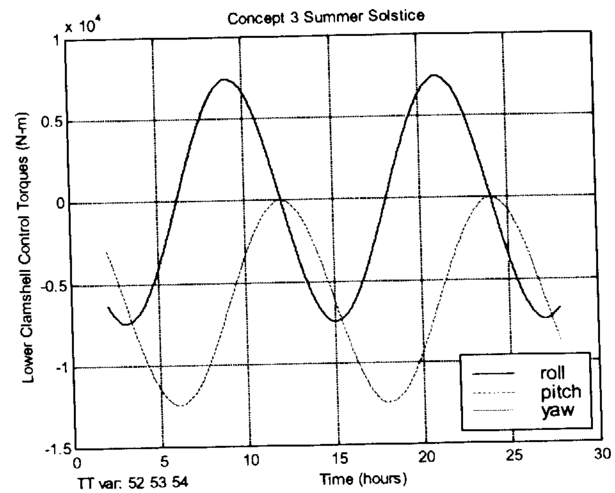


Figure B.2-7b: Lower Clamshell Control Torques vs. Time (Summer Solstice)

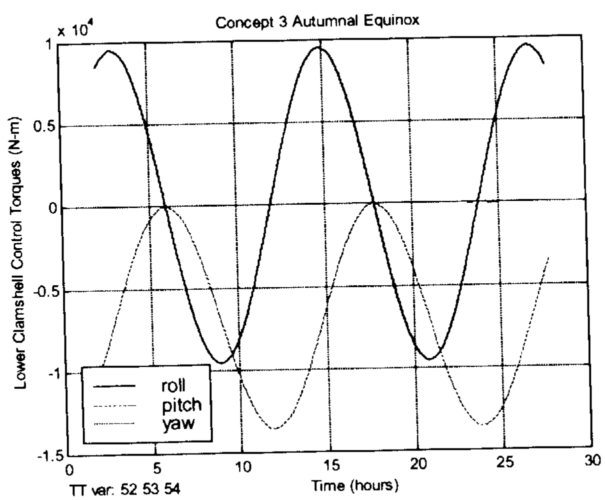


Figure B.2-7c: Lower Clamshell Control Torques vs. Time (Autumnal Equinox)

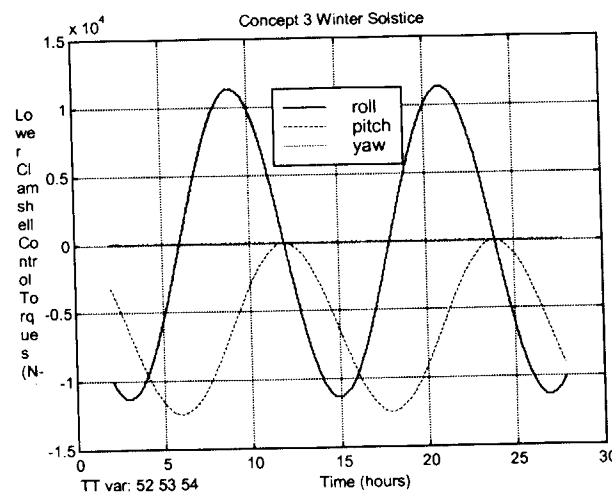


Figure B.2-7d: Lower Clamshell Control Torques vs. Time (Winter Solstice)

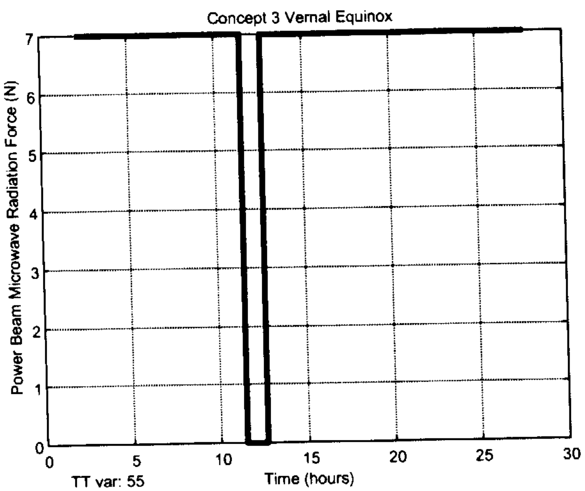


Figure B.2-8a: Power Beam Microwave Radiation Force vs. Time (Vernal Equinox)

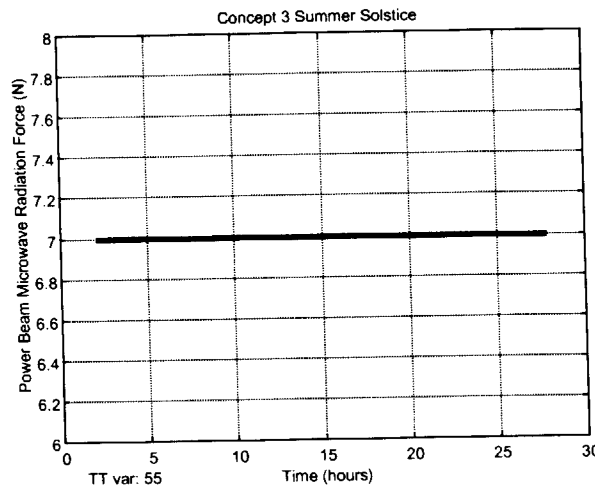


Figure B.2-8b: Power Beam Microwave Radiation Force vs. Time (Summer Solstice)

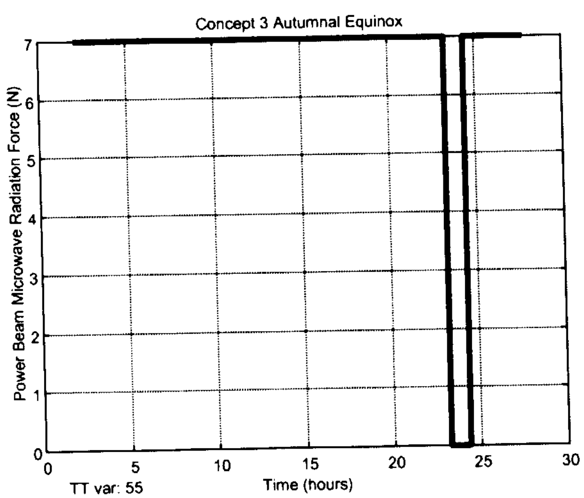


Figure B.2-8c: Power Beam Microwave Radiation Force vs. Time (Autumnal Equinox)

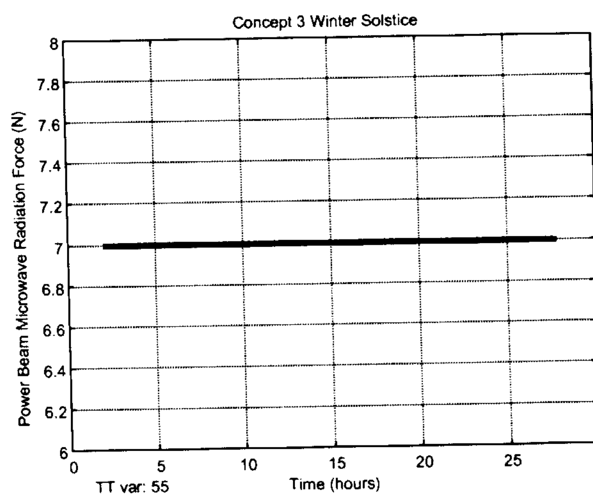


Figure B.2-8d: Power Beam Microwave Radiation Force vs. Time (Winter Solstice)

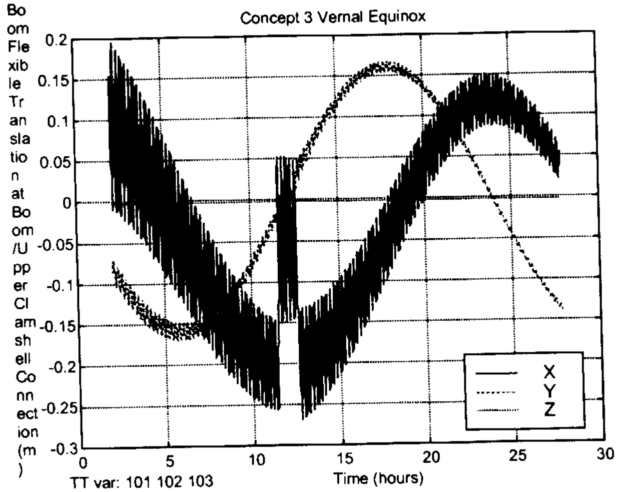


Figure B.2-9a: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

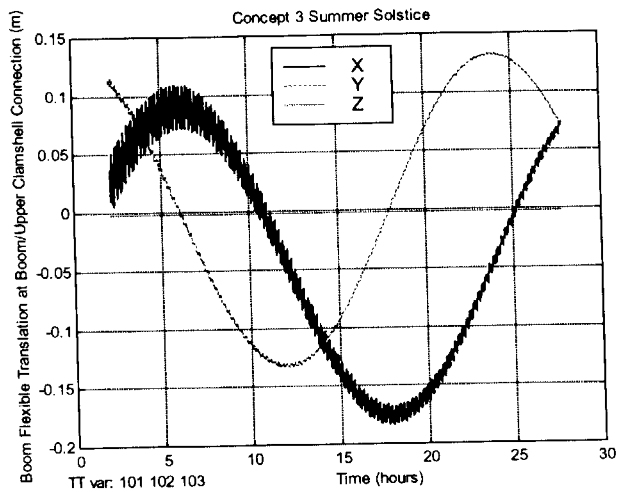


Figure B.2-9b: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Summer Solstice)

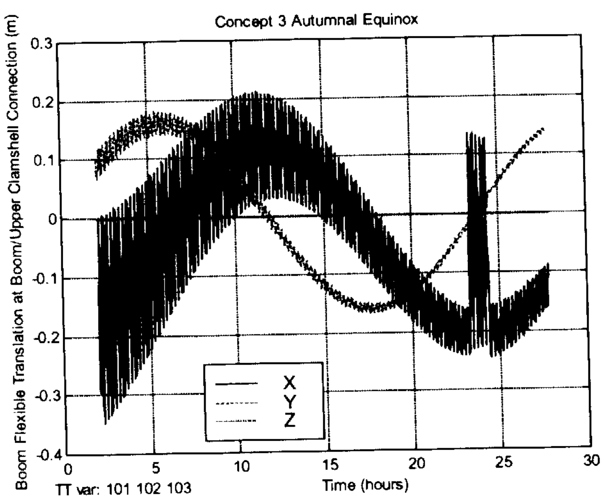


Figure B.2-9c: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Autumnal Equinox)

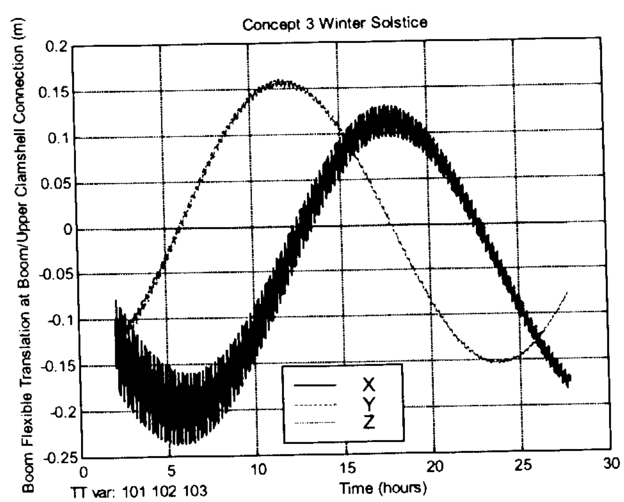


Figure B.2-9d: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Winter Solstice)

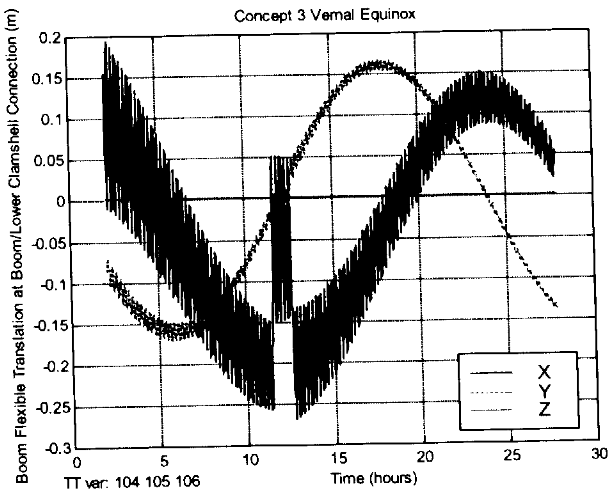


Figure B.2-10a: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

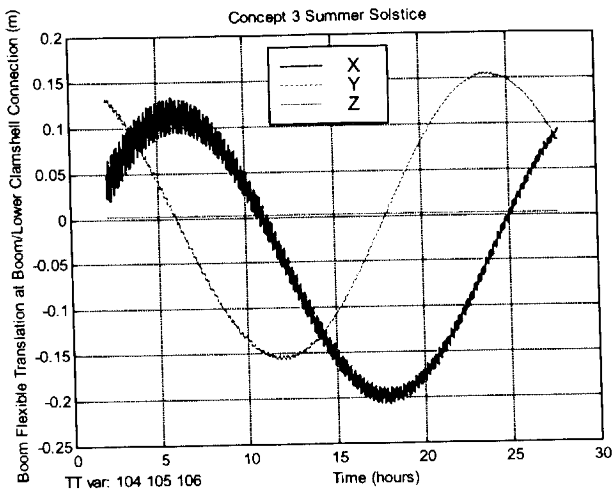


Figure B.2-10b: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Summer Solstice)

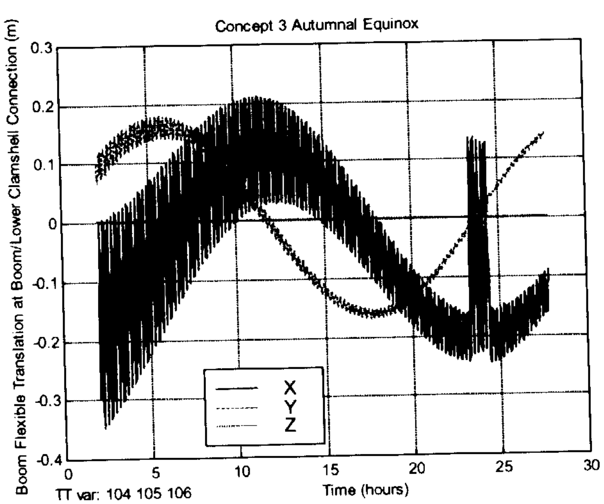


Figure B.2-10c: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Autumnal Equinox)

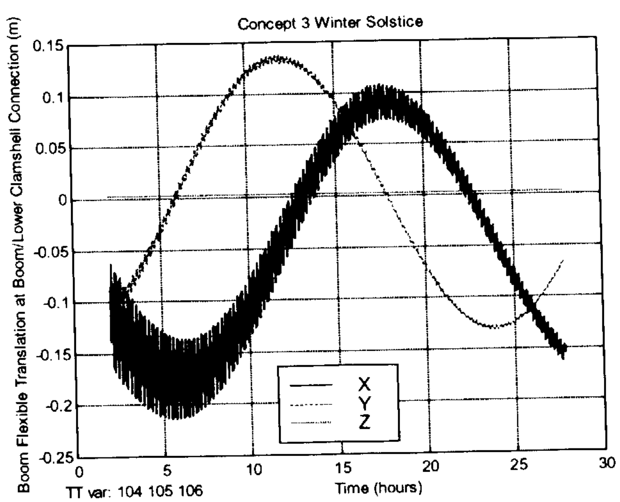


Figure B.2-10d: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Winter Solstice)

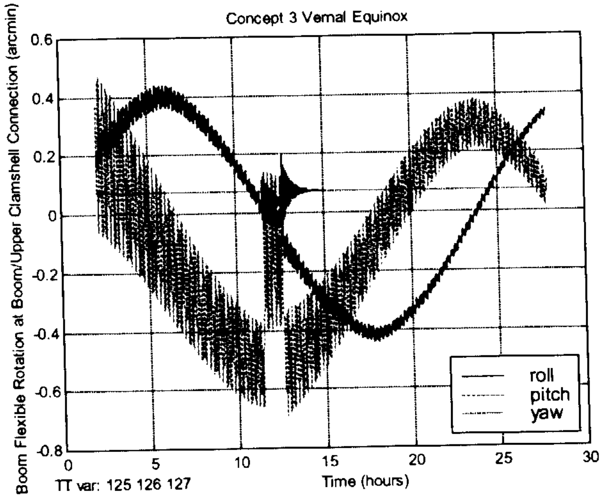


Figure B.2-11a: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

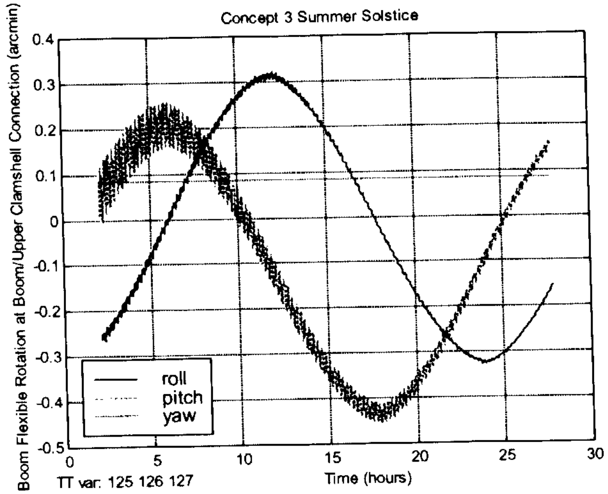


Figure B.2-11b: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Summer Solstice)

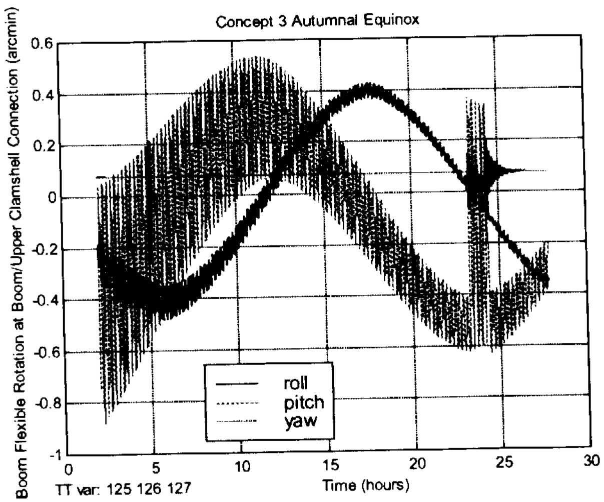


Figure B.2-11c: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Autumnal Equinox)

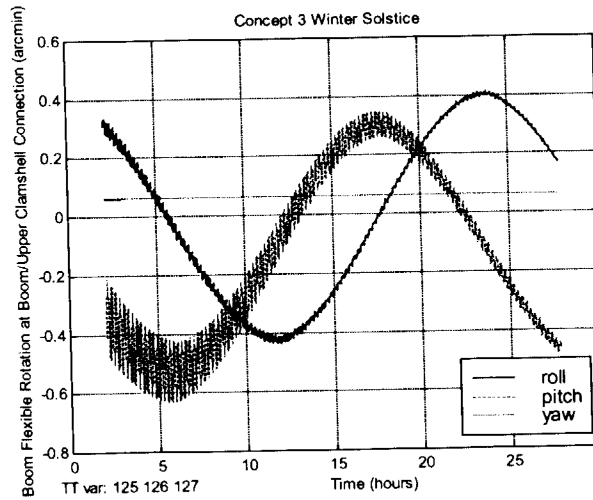


Figure B.2-11d: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Winter Solstice)

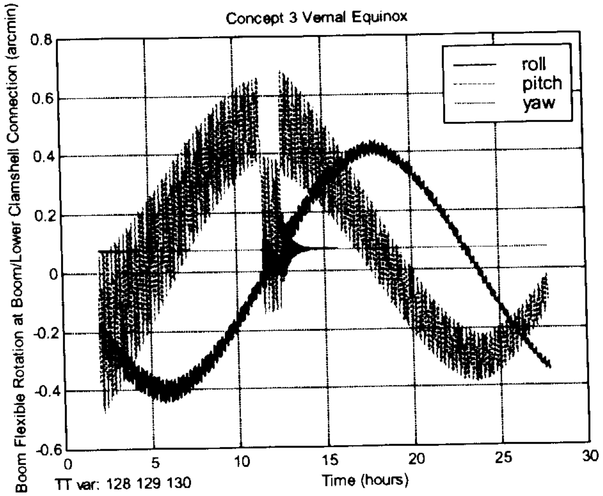


Figure B.2-12a: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

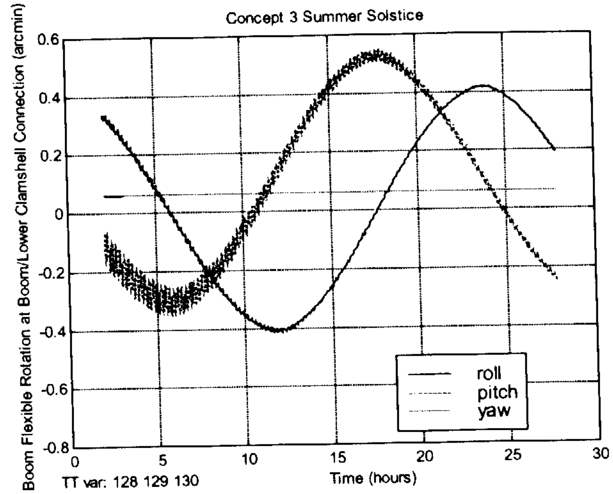


Figure B.2-12b: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Summer Solstice)

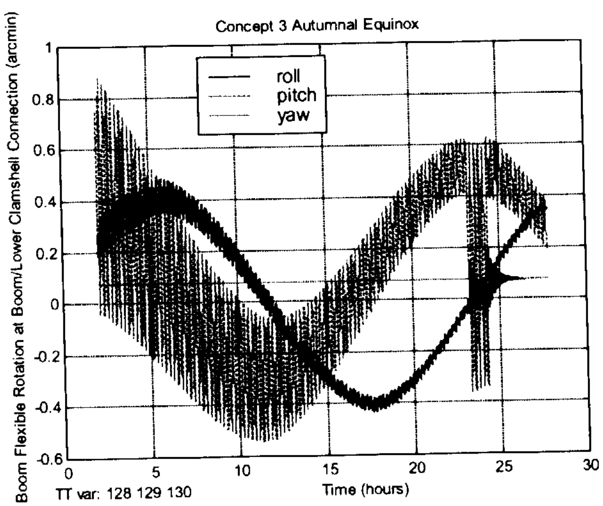


Figure B.2-12c: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Autumnal Equinox)

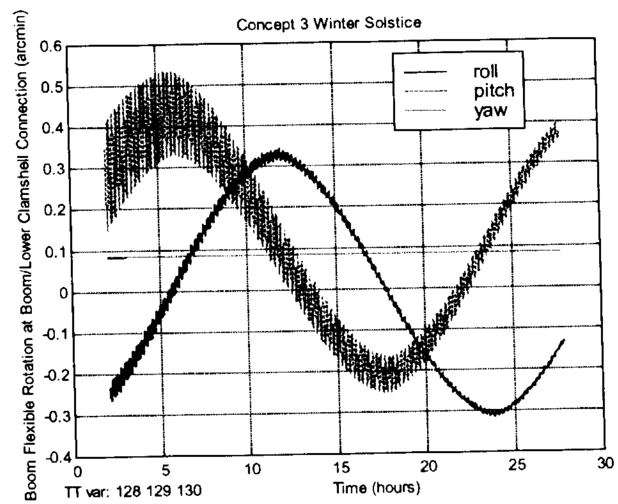


Figure B.2-12d: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Winter Solstice)

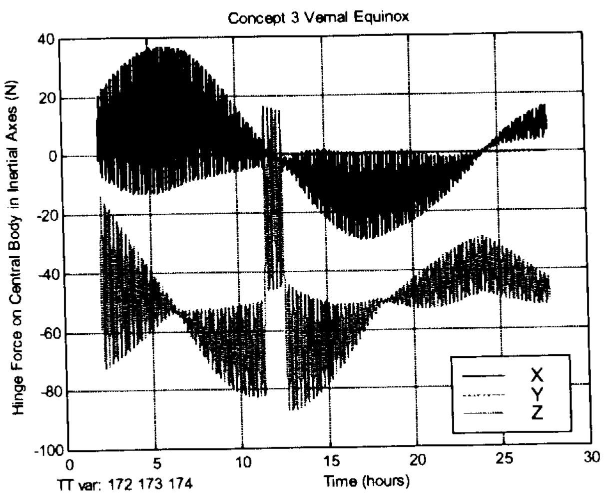


Figure B.2-13a: Hinge Force on Central Body in Inertial Axes vs. Time (Vernal Equinox)

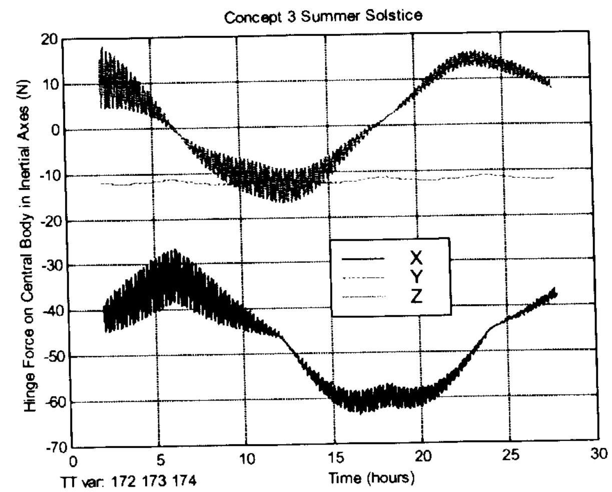


Figure B.2-13b: Hinge Force on Central Body in Inertial Axes vs. Time (Summer Solstice)

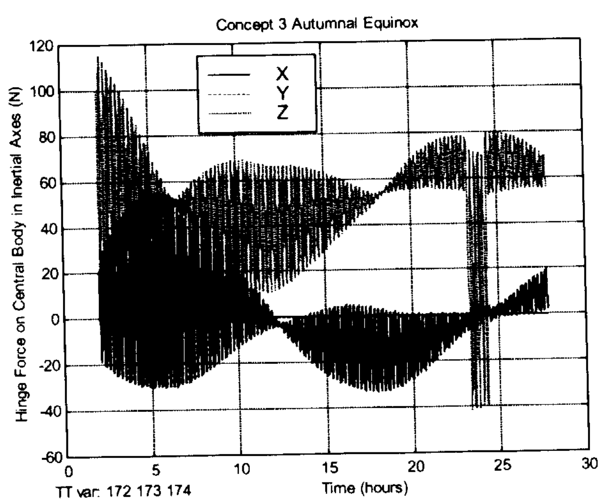


Figure B.2-13c: Hinge Force on Central Body in Inertial Axes vs. Time (Autumnal Equinox)

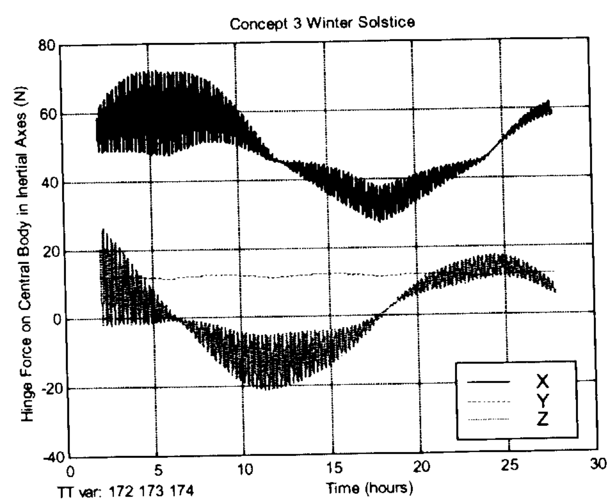


Figure B.2-13d: Hinge Force on Central Body in Inertial Axes vs. Time (Winter Solstice)

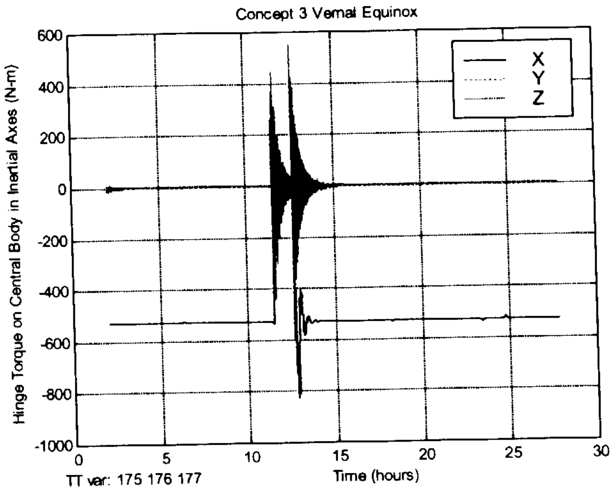


Figure B.2-14a: Hinge Torque on Central Body in Inertial Axes vs. Time (Vernal Equinox)

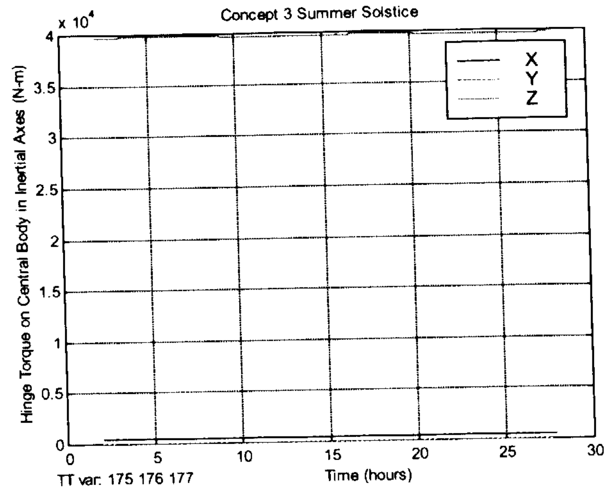


Figure B.2-14b: Hinge Torque on Central Body in Inertial Axes vs. Time (Summer Solstice)

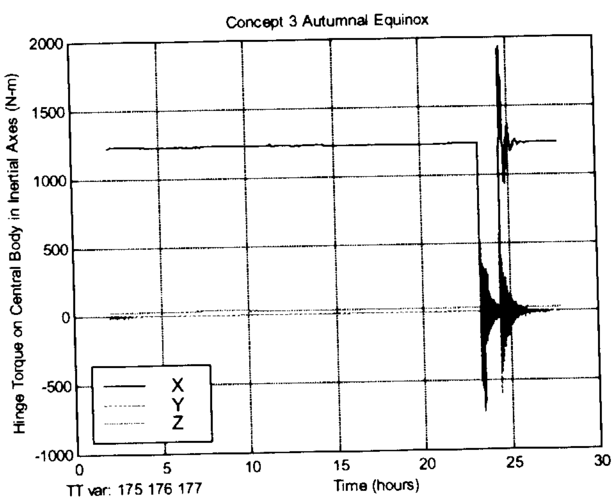


Figure B.2-14c: Hinge Torque on Central Body in Inertial Axes vs. Time (Autumnal Equinox)

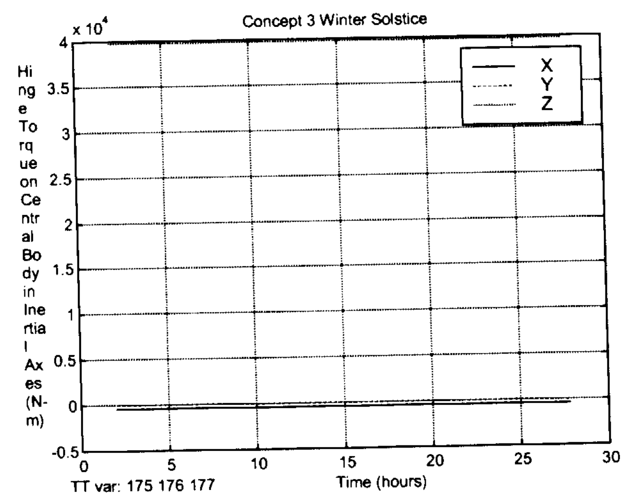


Figure B.2-14d: Hinge Torque on Central Body in Inertial Axes vs. Time (Winter Solstice)

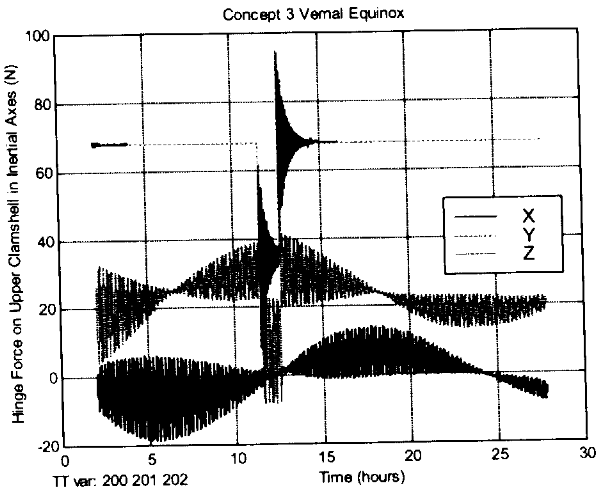


Figure B.2-15a: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Vernal Equinox)

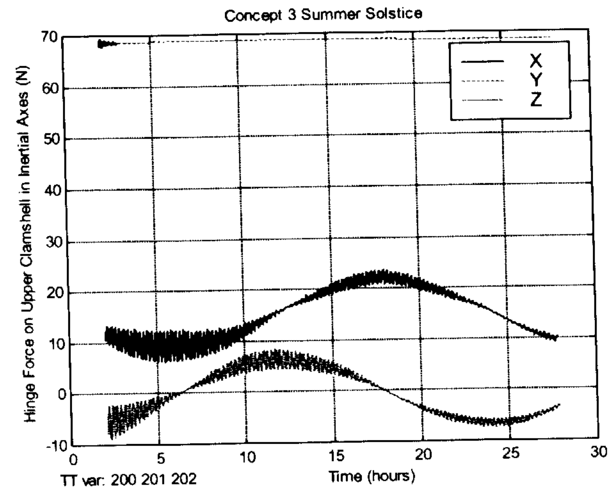


Figure B.2-15b: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Summer Solstice)

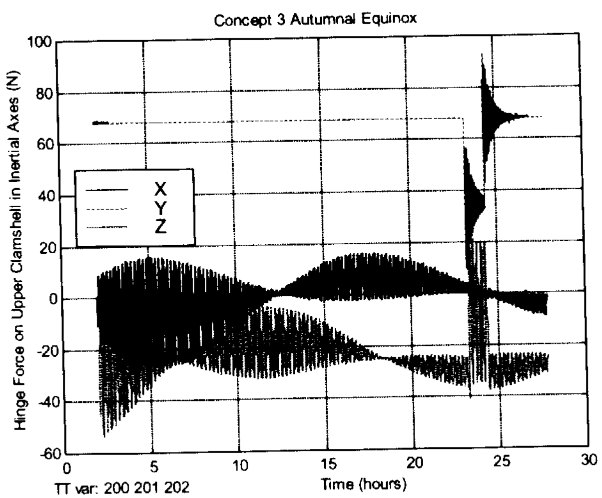


Figure B.2-15c: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Autumnal Equinox)

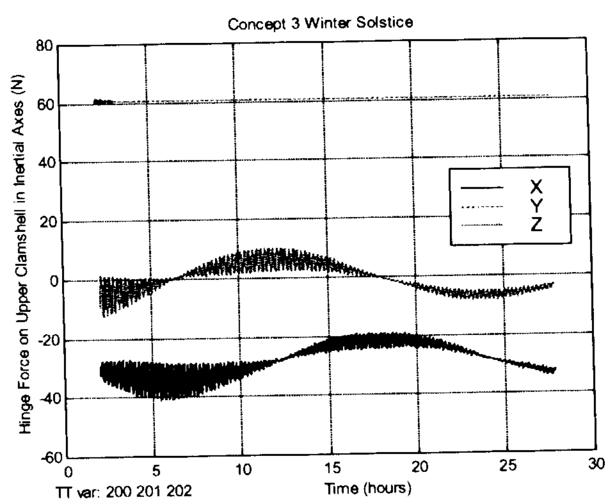


Figure B.2-15d: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Winter Solstice)

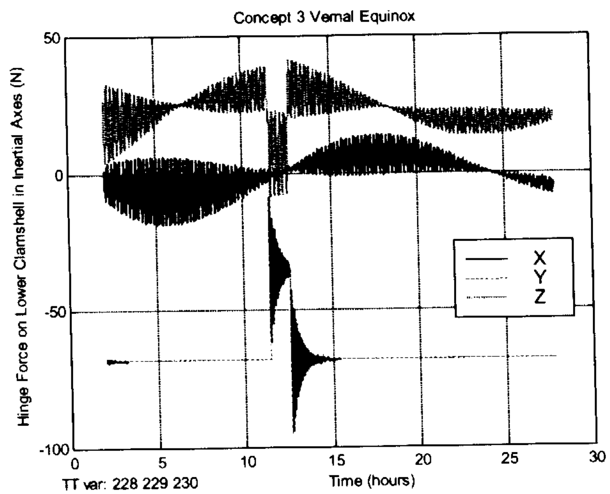


Figure B.2-16a: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Vernal Equinox)

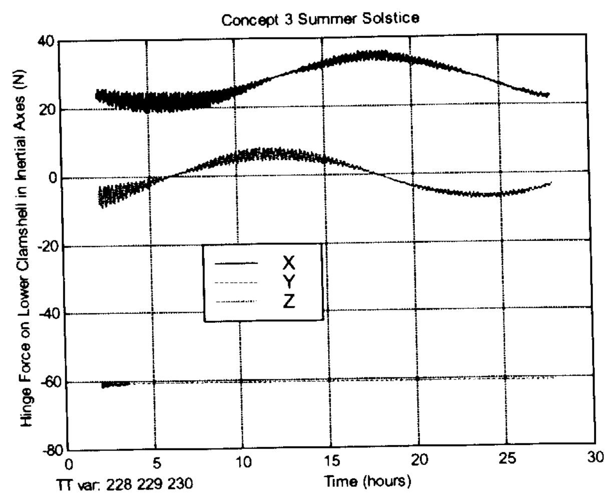


Figure B.2-16b: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Summer Solstice)

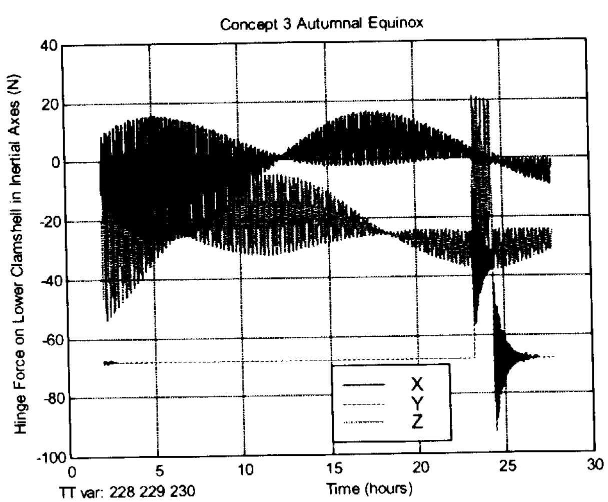


Figure B.2-16c: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Autumnal Equinox)

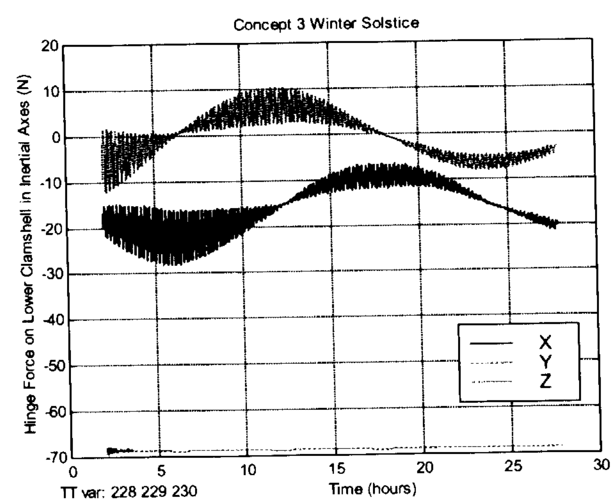


Figure B.2-16d: Hinge Force on Lower Clamshell
in Inertial Axes vs. Time
(Winter Solstice)

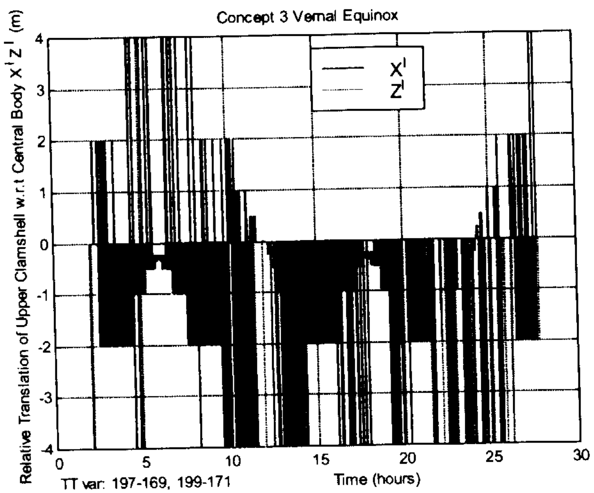


Figure B.2-17a: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

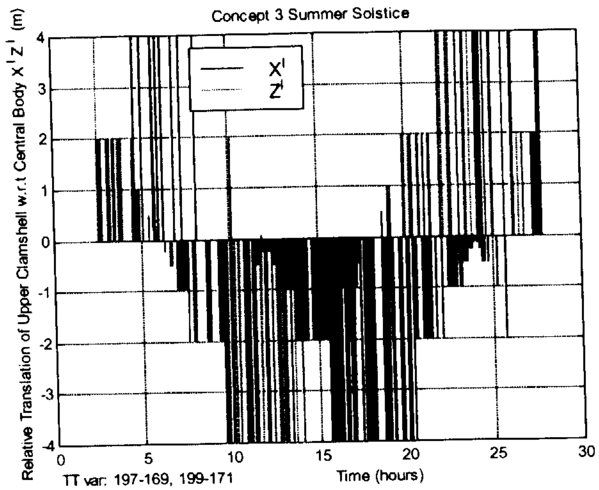


Figure B.2-17b: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Summer Solstice)

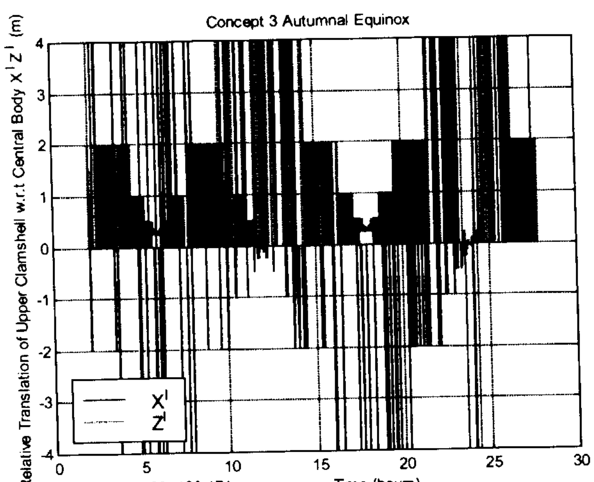


Figure B.2-17c: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Autumnal Equinox)

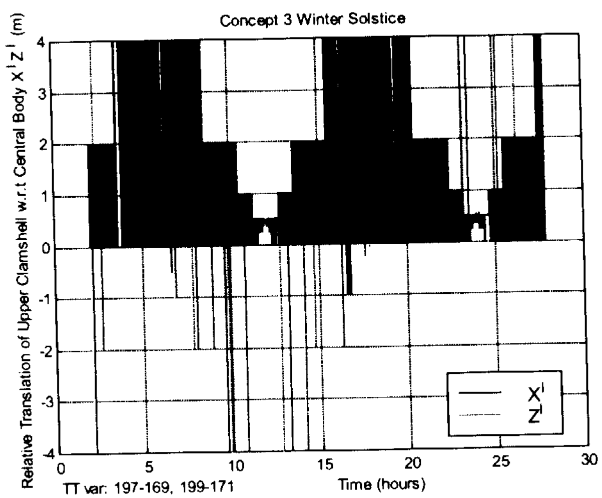


Figure B.2-17d: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Winter Solstice)

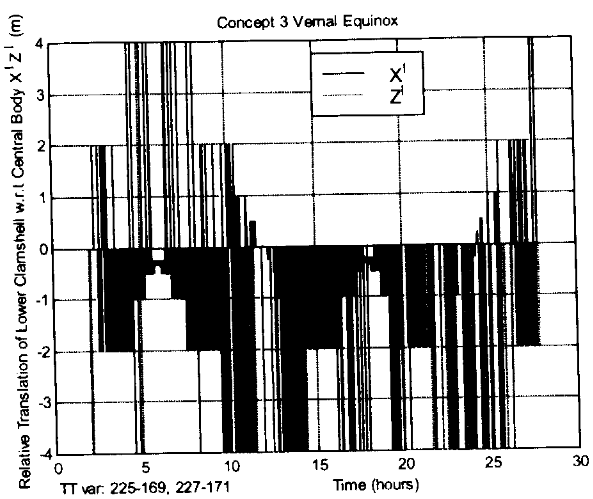


Figure B.2-18a: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

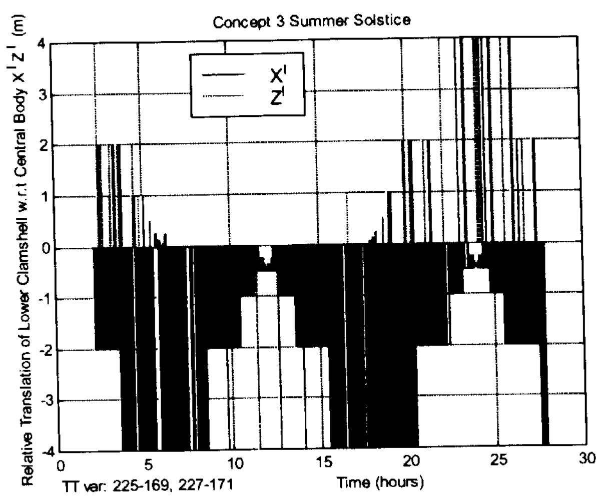


Figure B.2-18b: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Summer Solstice)

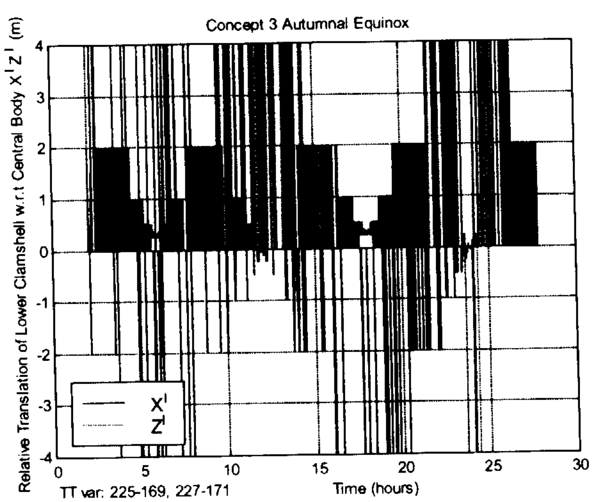


Figure B.2-18c: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Autumnal Equinox)

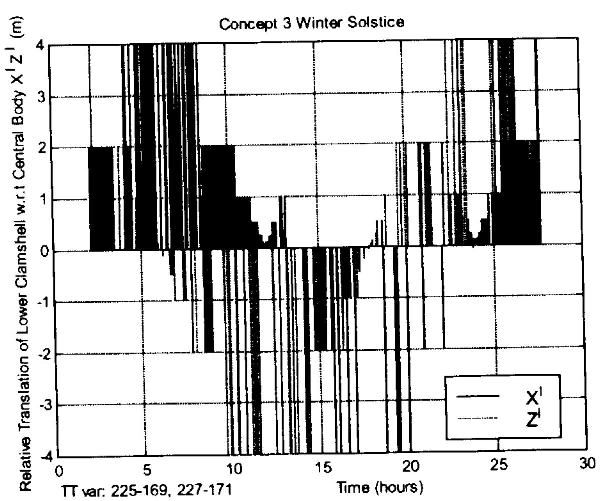


Figure B.2-18d: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Winter Solstice)

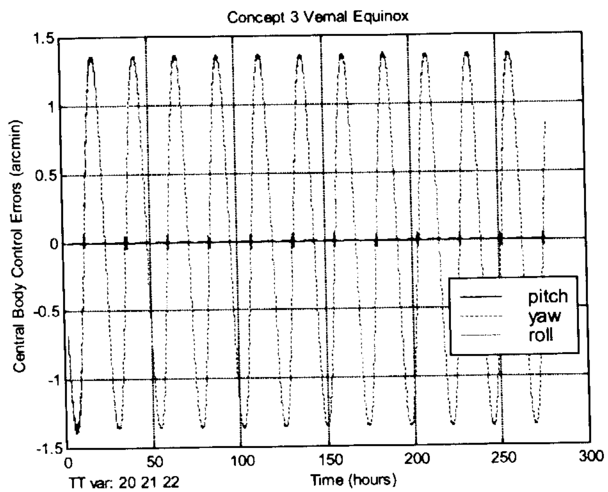


Figure B.2-19: Central Body Control Errors vs. Time (Vernal Equinox)

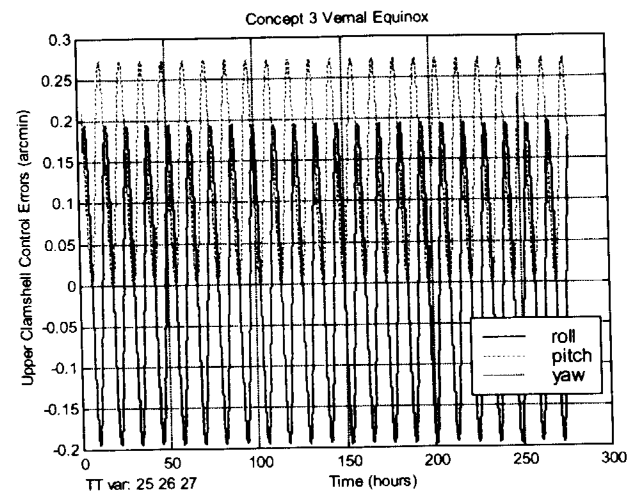


Figure B.2-20: Upper Clamshell Control Errors vs. Time (Vernal Equinox)

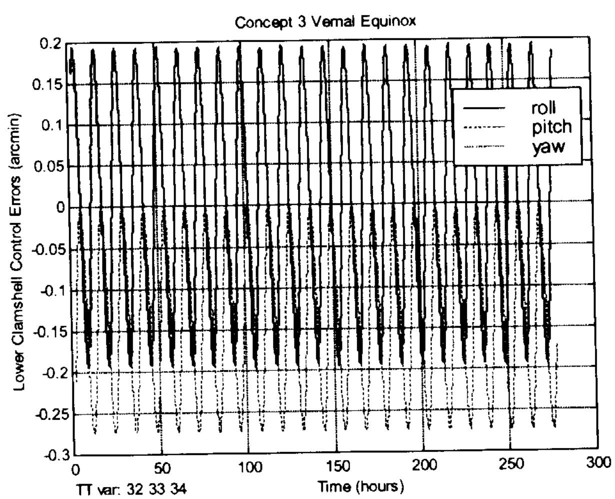


Figure B.2-21: Lower Clamshell Control Errors vs. Time (Vernal Equinox)

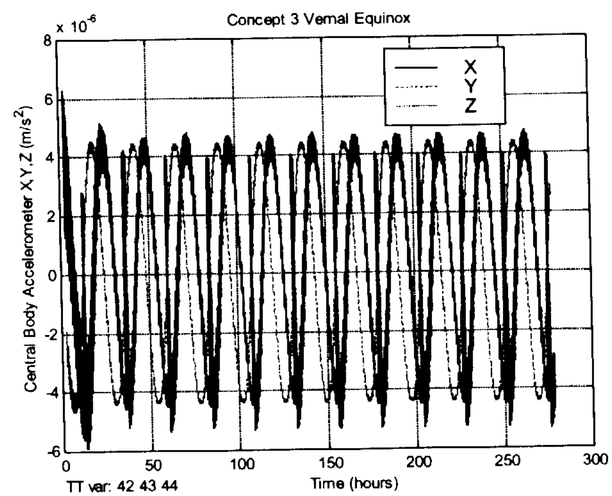


Figure B.2-22: Central Body Accelerometer vs. Time (Vernal Equinox)

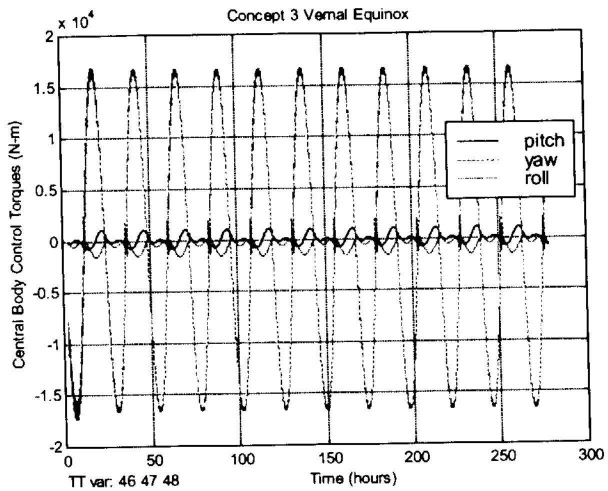


Figure B.2-23: Central Body Control Torques vs. Time
(Vernal Equinox)

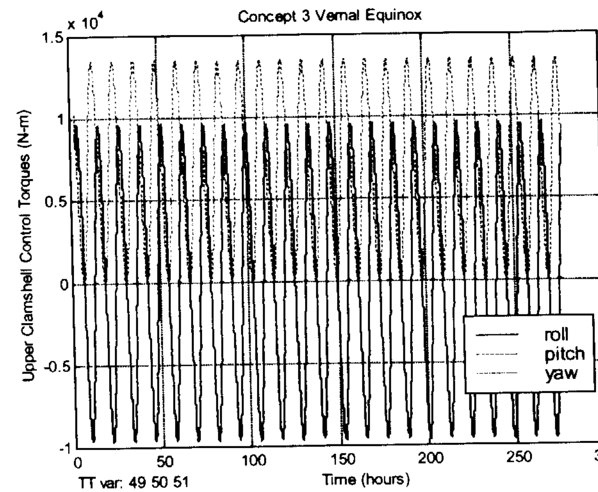


Figure B.2-24: Upper Clamshell Control Torques vs. Time
(Vernal Equinox)

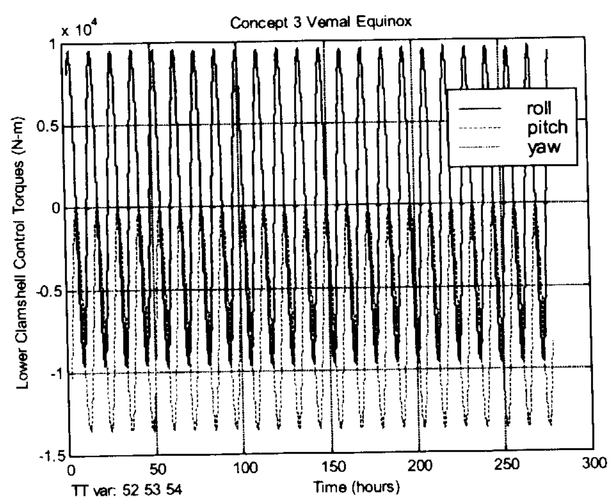


Figure B.2-25: Lower Clamshell Control Torques vs. Time
(Vernal Equinox)

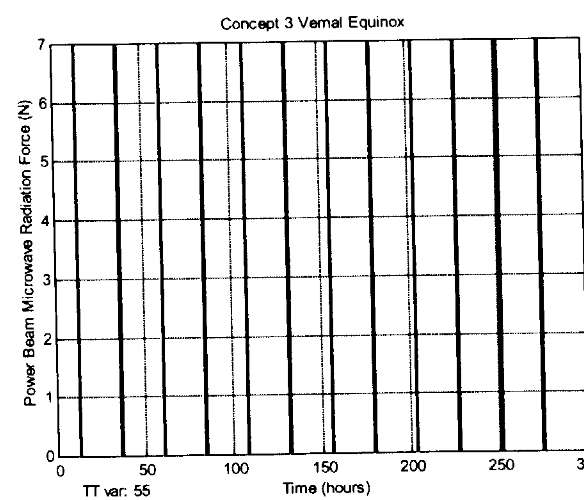


Figure B.2-26: Power Beam Microwave Radiation Force
vs. Time
(Vernal Equinox)

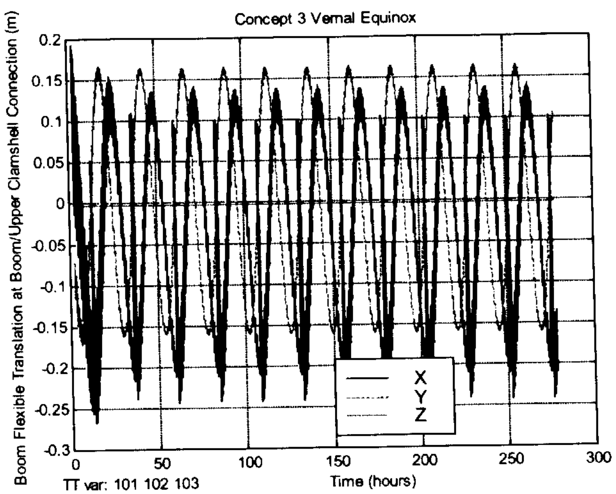


Figure B.2-27: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

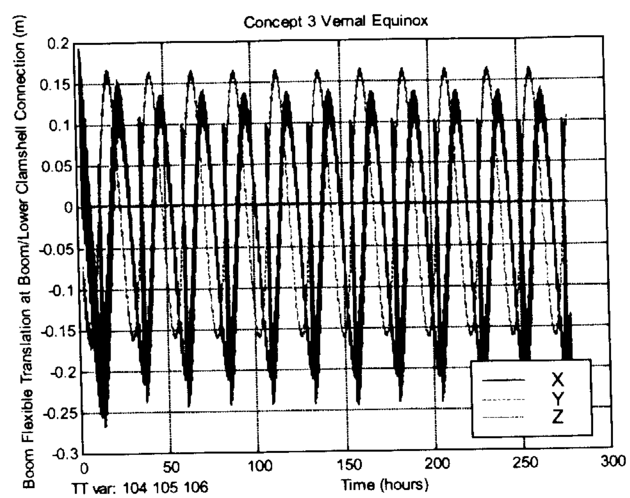


Figure B.2-28: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

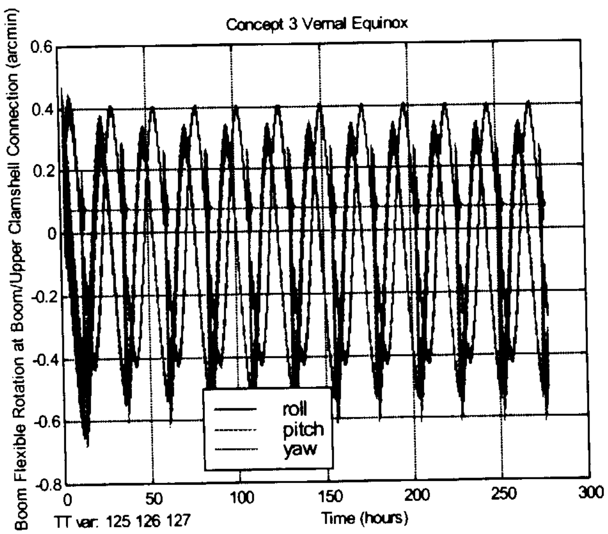


Figure B.2-29: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Vernal Equinox)

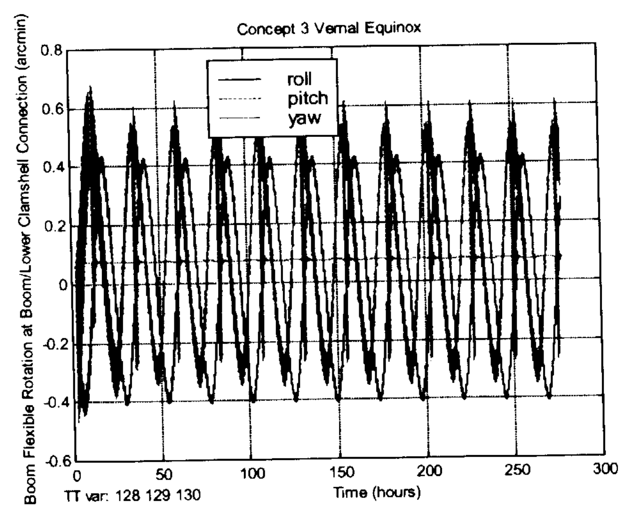


Figure B.2-30: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Vernal Equinox)

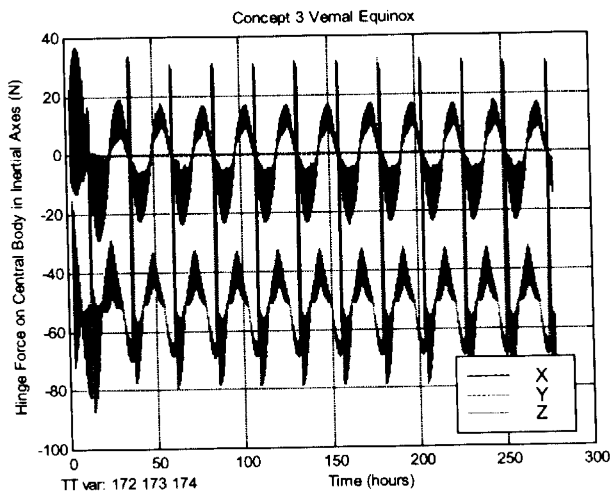


Figure B.2-31: Hinge Force on Central Body in Inertial Axes vs. Time (Vernal Equinox)

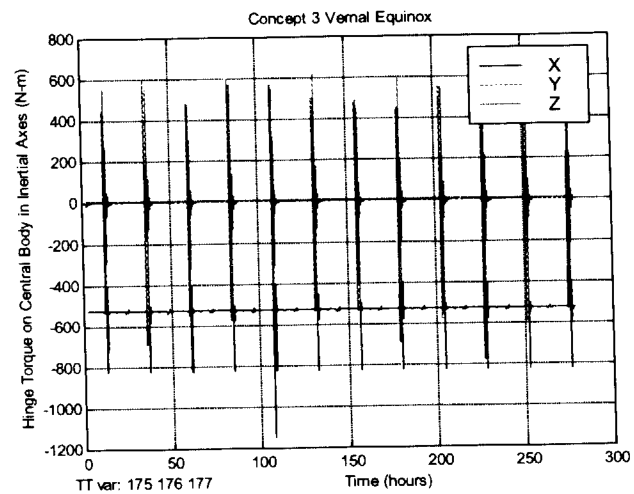


Figure B.2-32: Hinge Torque on Central Body in Inertial Axes vs. Time (Vernal Equinox)

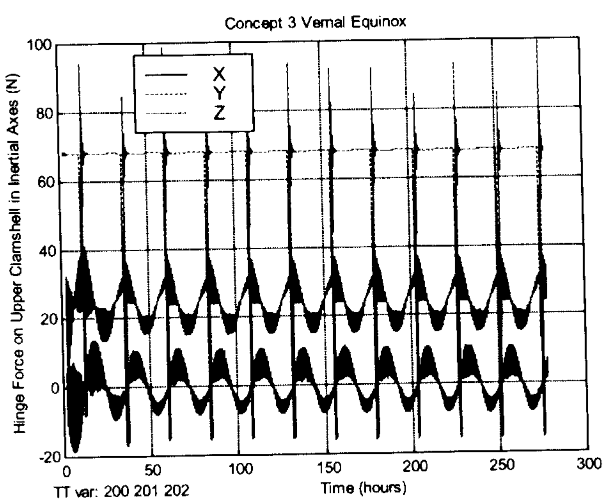


Figure B.2-33: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Vernal Equinox)

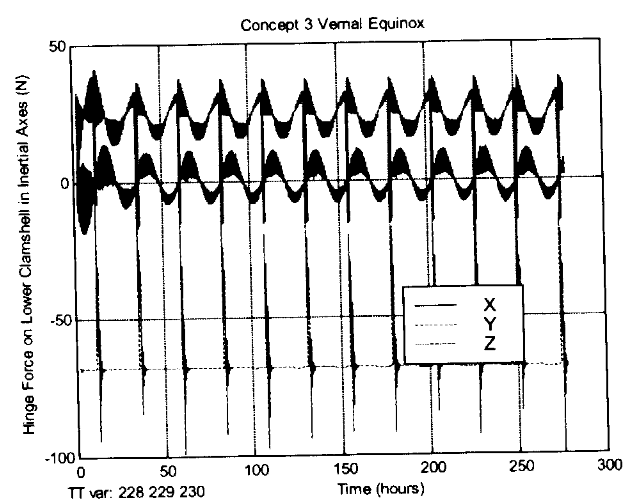


Figure B.2-34: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Vernal Equinox)

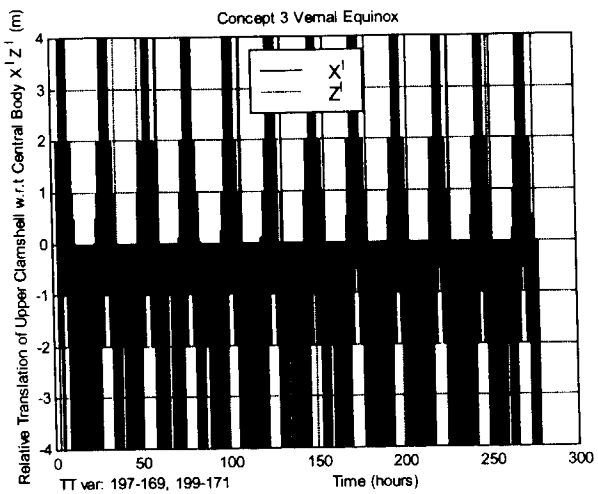


Figure B.2-35: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

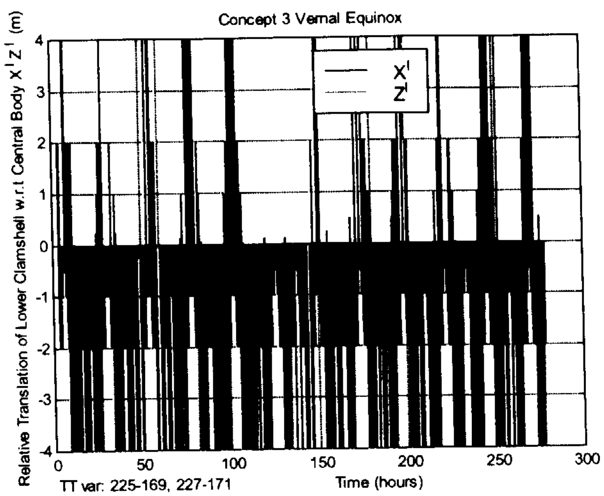


Figure B.2-36: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Vernal Equinox)

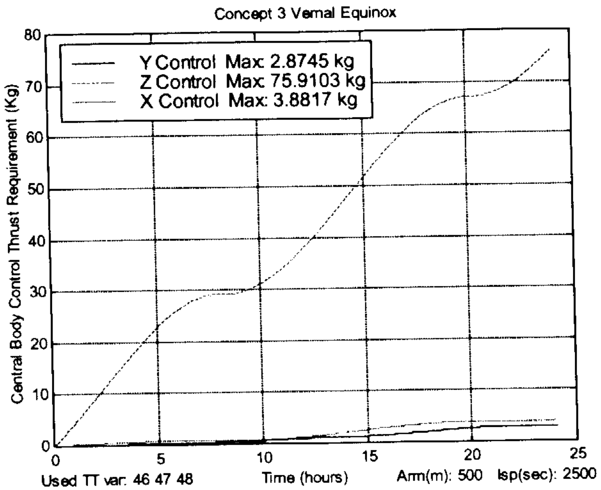


Figure B.2-37a: Central Body Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

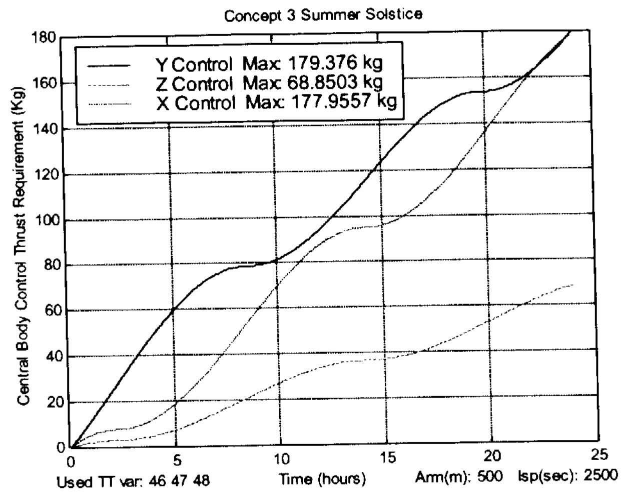


Figure B.2-37b: Central Body Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

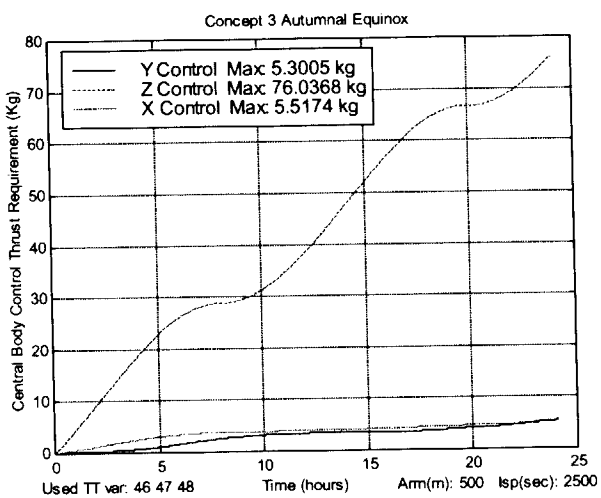


Figure B.2-37c: Central Body Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

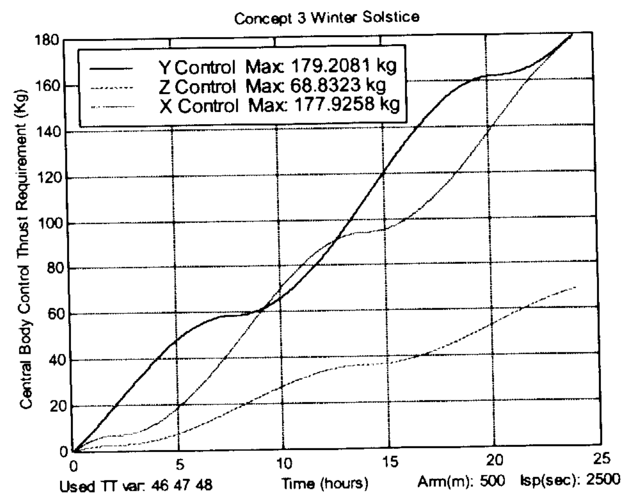


Figure B.2-37d: Central Body Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

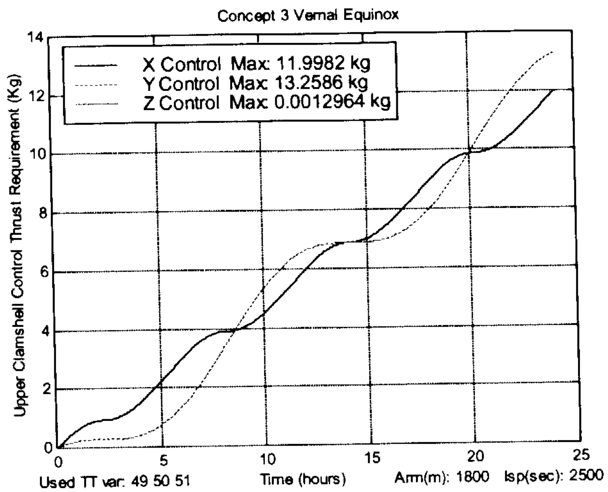


Figure B.2-38a: Upper Clamshell Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

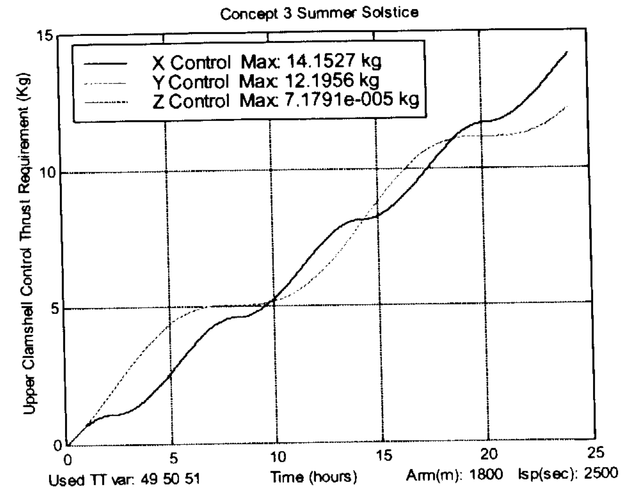


Figure B.2-38b: Upper Clamshell Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

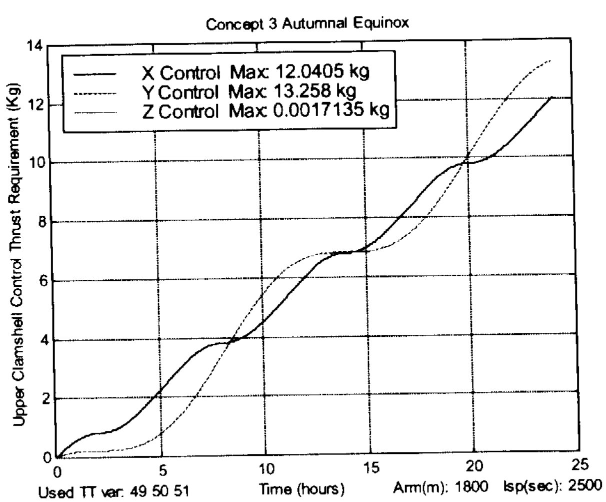


Figure B.2-38c: Upper Clamshell Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

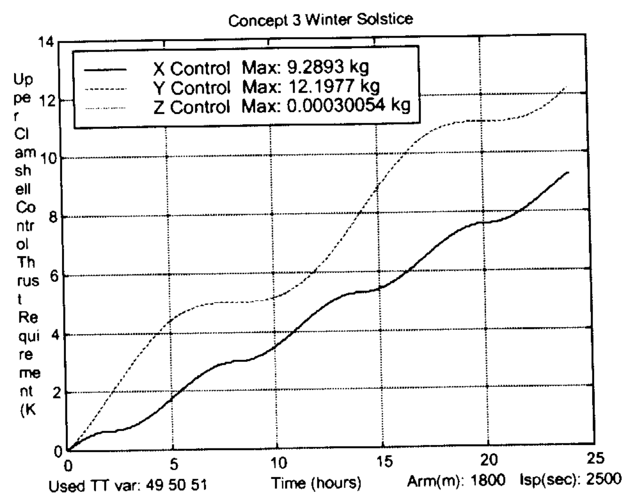


Figure B.2-38d: Upper Clamshell Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

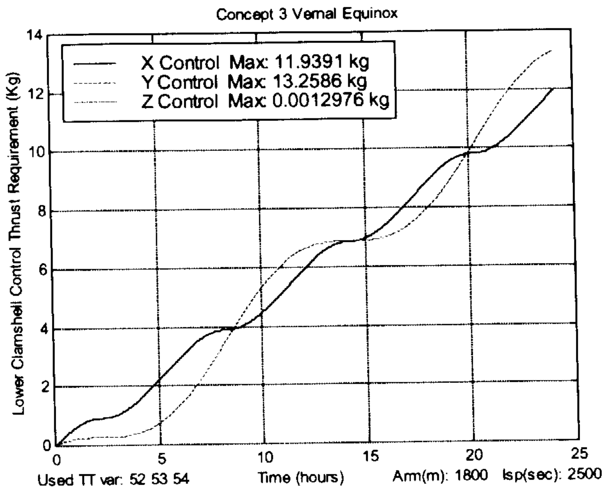


Figure B.2-39a: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

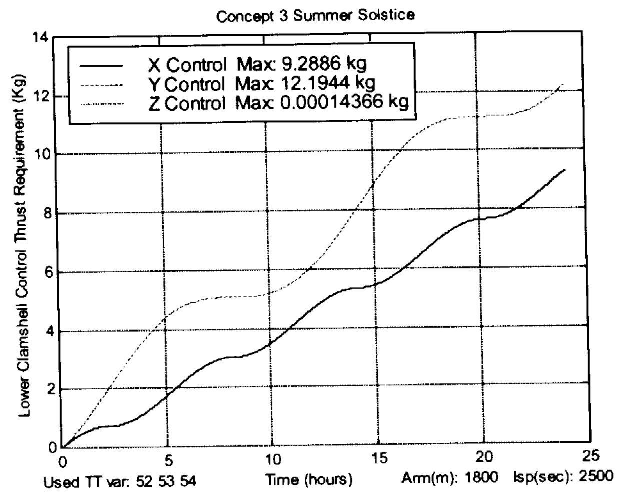


Figure B.2-39b: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

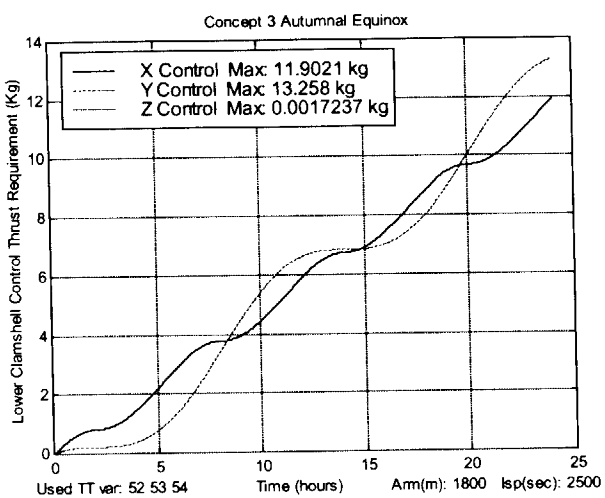


Figure B.2-39c: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

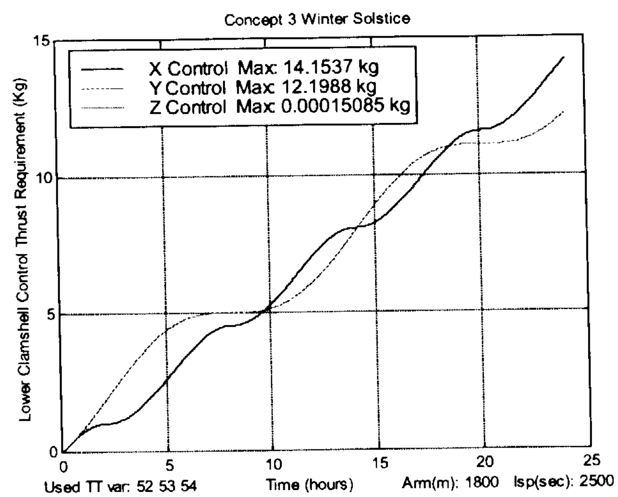


Figure B.2-39d: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

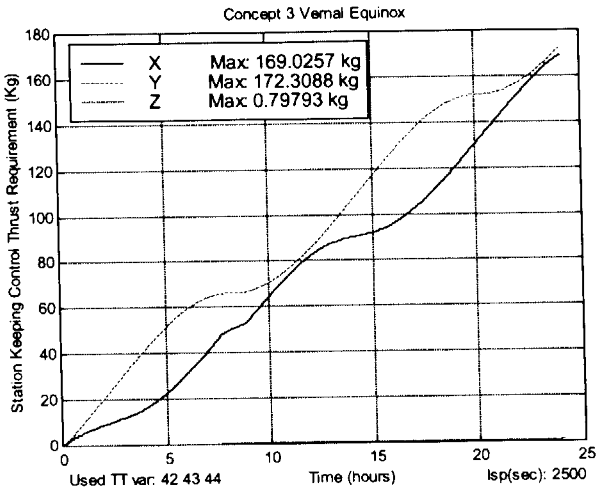


Figure B.2-40a: Estimated Station Keeping Control Thrust Requirement vs. Time for 1 Day (Vernal Equinox)

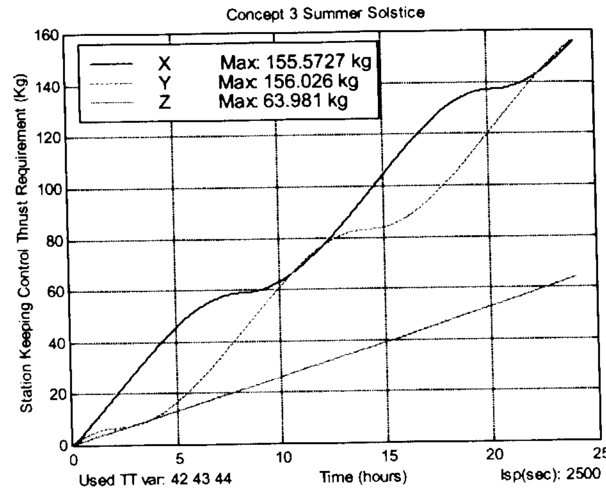


Figure B.2-40b: Estimated Station Keeping Clamshell Control Thrust Requirement vs. Time for 1 Day (Summer Solstice)

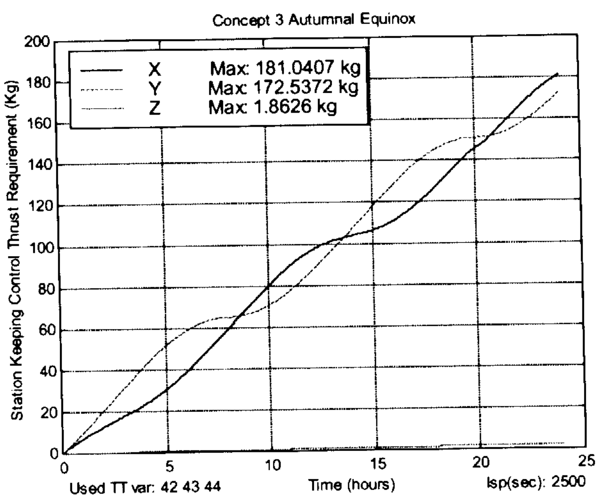


Figure B.2-40c: Estimated Station Keeping Control Thrust Requirement vs. Time for 1 Day (Autumnal Equinox)

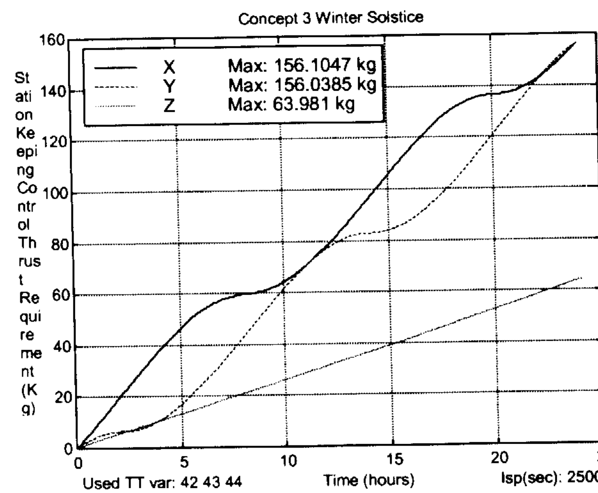


Figure B.2-39d: Estimated Station Keeping Control Thrust Requirement vs. Time for 1 Day (Winter Solstice)

Table B.2-1: Predicted Daily Thrust Requirements (Kg) (Concept 3)

	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			Total
Description	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.882	2.875	75.910	177.956	179.376	68.850	5.517	5.301	76.037	177.926	179.208	68.832	91.320	91.690	72.407	255.417
Upper Clamshell Control	11.998	13.259	.00130	14.153	12.196	7.2E-5	12.041	13.258	.00171	9.289	12.198	3.01E-4	11.870	12.728	8.5E-4	24.599
Lower Clamshell Control	11.939	13.259	.00130	9.289	12.194	.00014	11.902	13.258	.00172	14.154	12.199	1.51E-4	11.821	12.728	8.3E-4	24.550
Total	27.819	29.393	75.913	201.398	203.768	68.850	29.460	31.817	76.040	201.369	203.605	68.832	115.011	117.146	72.409	304.566

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m

Table B.2-2: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 3)

	Vernal Equinox			Summer Solstice			Autumnal Equinox			Winter Solstice			Daily Average			Total
Description	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	169.026	172.309	.798	155.573	156.026	63.981	181.041	172.537	1.863	156.105	156.039	63.981	165.436	164.228	32.656	362.320

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg

TABLE B.2-3: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 3)

	Daily Total				Yearly Total			
Description	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control	Total (1 Year)
Central Body Control	91.320	91.690	72.407	255.417	33355.	33490.	26447.	93292.
Upper Clamshell Control	11.870	12.728	8.5E-4	24.599	4336.	4649.	--	8985.
Lower Clamshell Control	11.821	12.728	8.5E-4	24.550	4318.	4649.	--	8967.
Total	115.011	117.146	72.409	304.566	42009.	42788.	26447.	111244.

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m
2) 1 Year = 365.25 days

TABLE B.2-4: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 3)

	Daily Total				Yearly Total			
Description	X	Y	Z	Total (1 Day)	X	Y	Z	Total (1 Year)
Station Keeping Control	165.436	164.228	32.656	362.320	60425.	59984.	11928.	132337.

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) 1 Year = 365.25 days

B.3 – TREETOPS simulation results Comparison of Concept 1, 2A, 2B and 3 and Thrust Requirements for Concept 2A and 2B

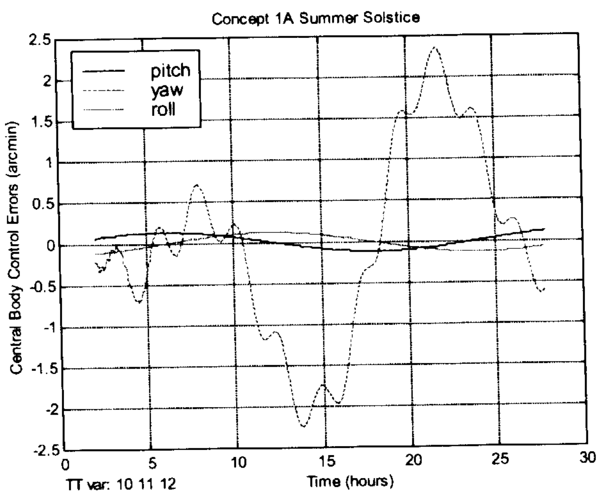


Figure B.3-1a: Central Body Control Errors vs. Time (Concept 1)

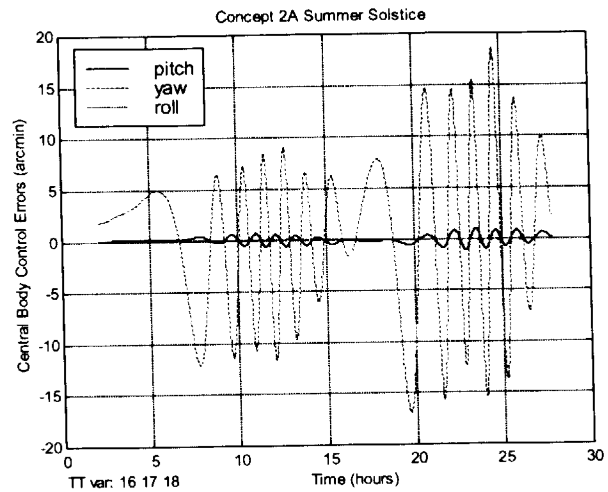


Figure B.3-1b: Central Body Control Errors vs. Time (Concept 2A)

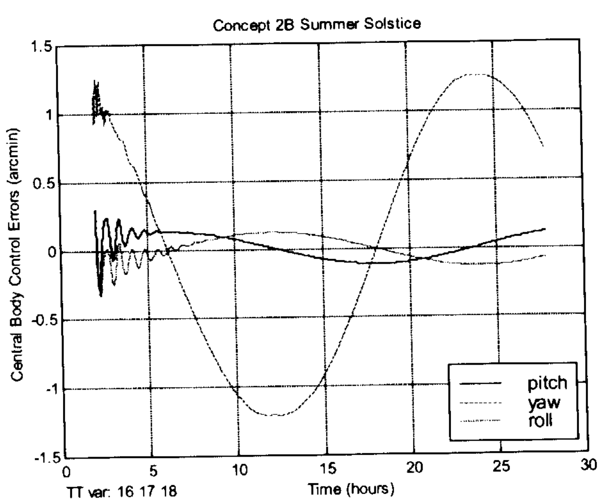


Figure B.3-1c: Central Body Control Errors vs. Time (Concept 2B)

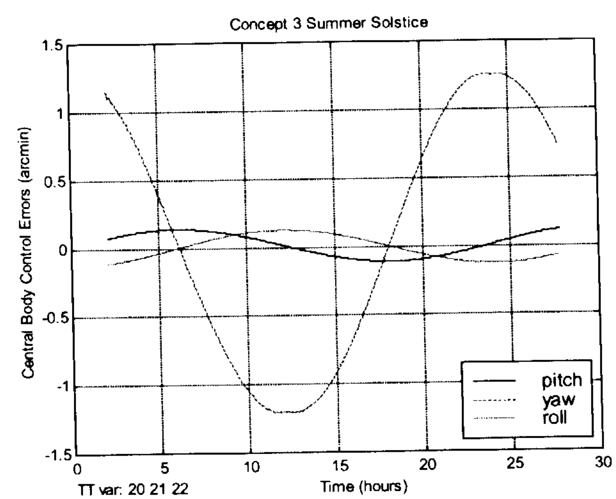


Figure B.3-1d: Central Body Control Errors vs. Time (Concept 3)

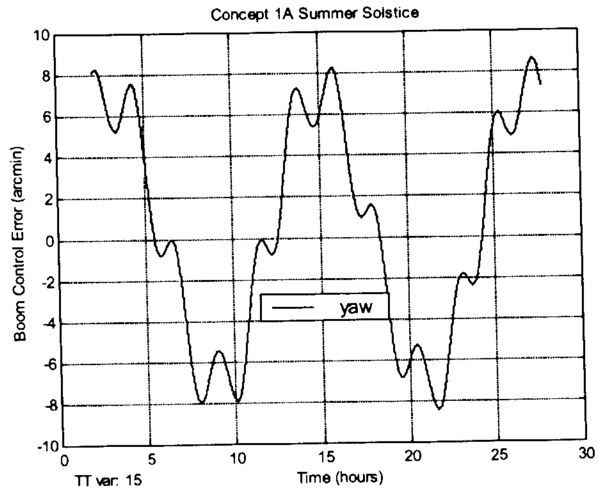


Figure B.3-2a: Boom Control Errors vs. Time
(Concept 1)

N/A

Figure B.3-2b: Boom Control Errors vs. Time
(Concept 2A)

N/A

Figure B.3-2c: Boom Control Errors vs. Time
(Concept 2B)

N/A

Figure B.3-2d: Boom Control Errors vs. Time
(Concept 3)

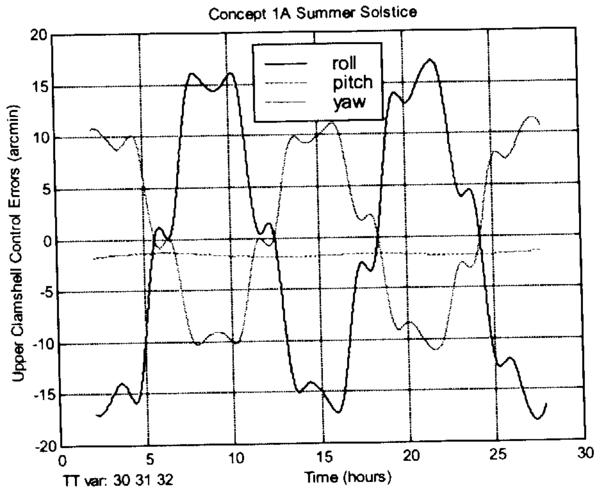


Figure B.3-3a: Upper Clamshell Control Errors vs. Time (Concept 1)

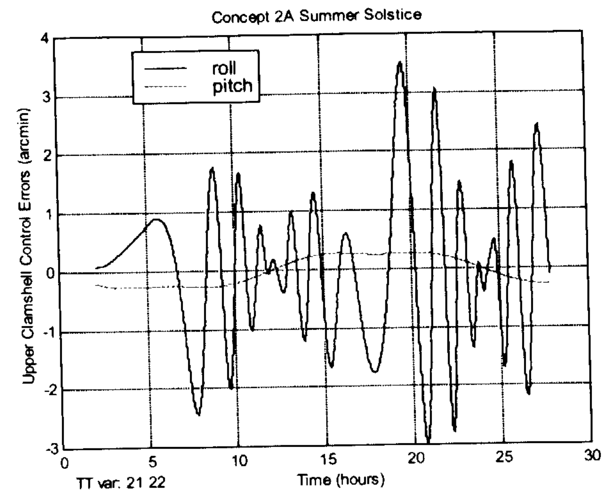


Figure B.3-3b: Upper Clamshell Control Errors vs. Time (Concept 2A)

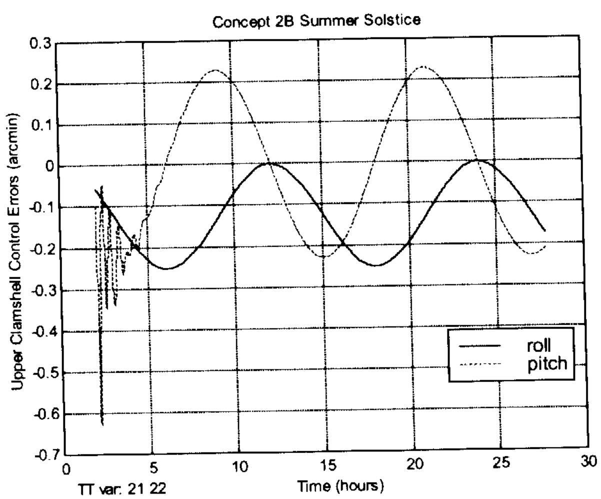


Figure B.3-3c: Upper Clamshell Control Errors vs. Time (Concept 2B)

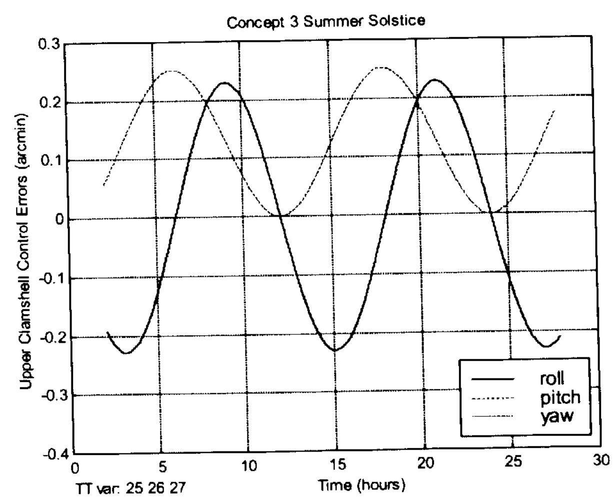


Figure B.3-3d: Upper Clamshell Control Errors vs. Time (Concept 3)

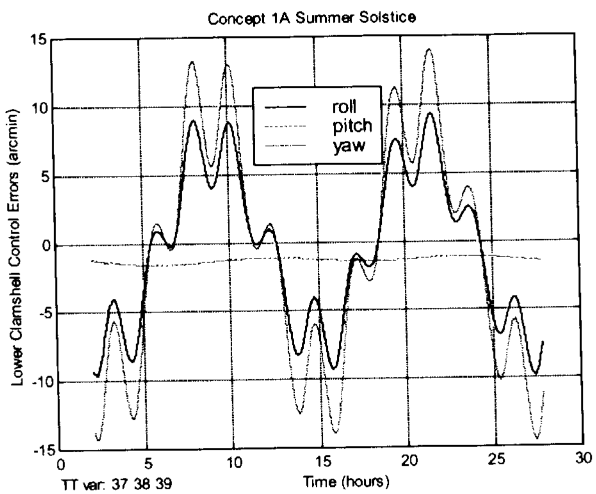


Figure B.3-4a: Lower Clamshell Control Errors vs. Time (Concept 1)

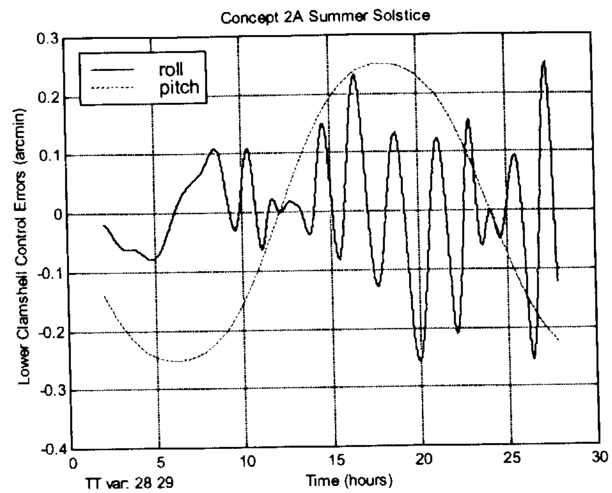


Figure B.3-4b: Lower Clamshell Control Errors vs. Time (Concept 2A)

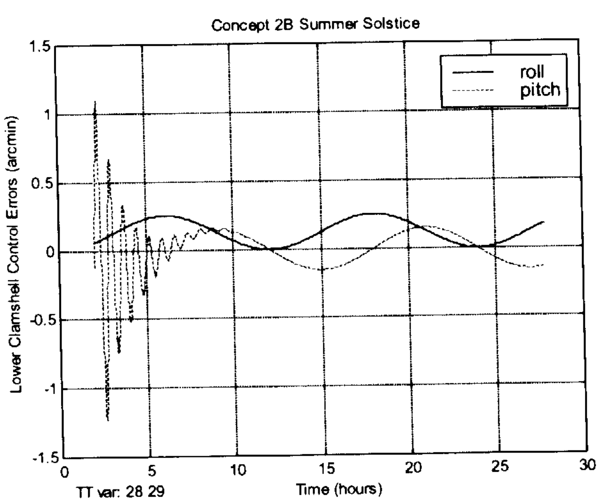


Figure B.3-4c: Lower Clamshell Control Errors vs. Time (Concept 2B)

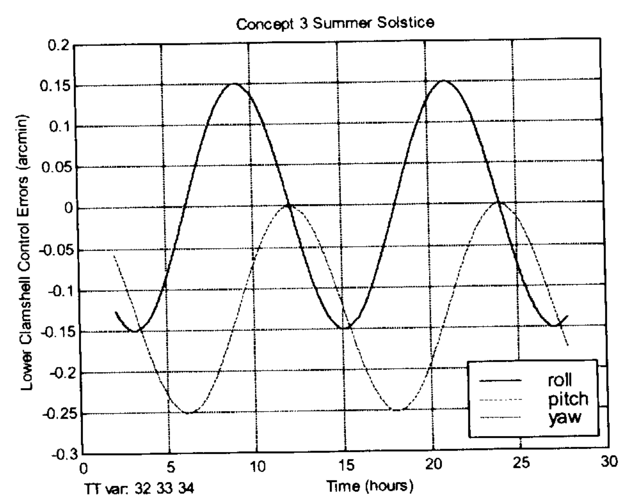


Figure B.3-4d: Lower Clamshell Control Errors vs. Time (Concept 3)

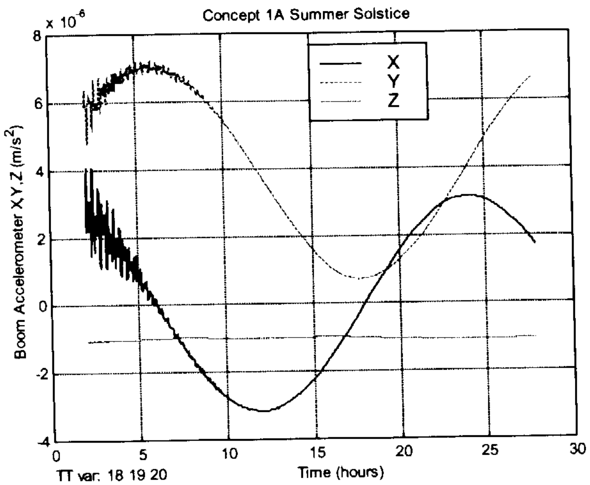


Figure B.3-5a: Central Body Accelerometer vs. Time (Concept 1)

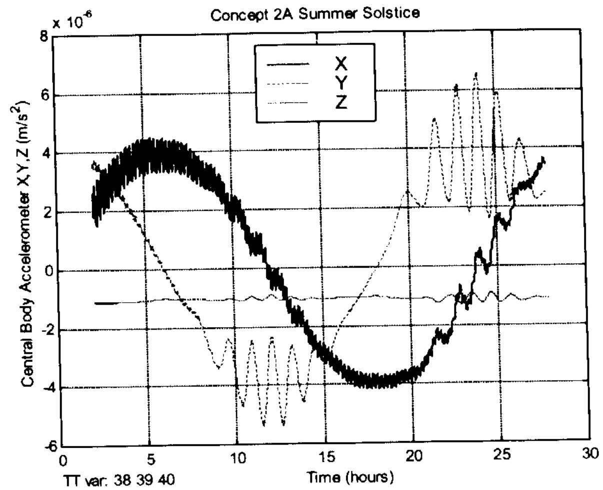


Figure B.3-5b: Central Body Accelerometer vs. Time (Concept 2A)

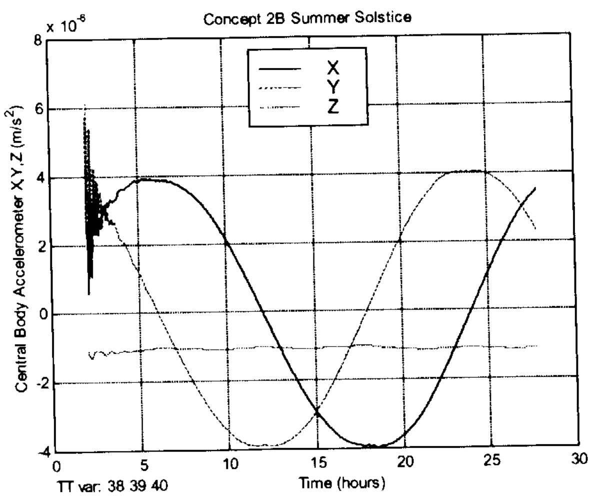


Figure B.3-5c: Central Body Accelerometer vs. Time (Concept 2B)

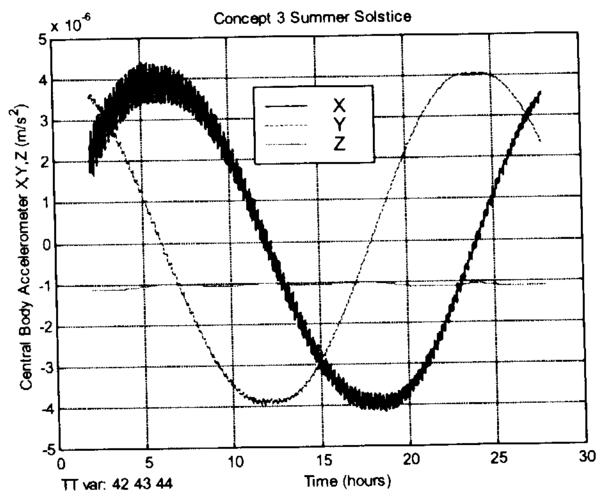


Figure B.3-5d: Central Body Accelerometer vs. Time (Concept 3)

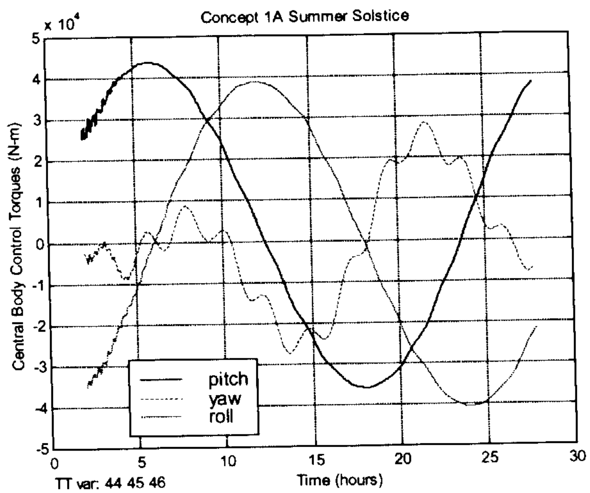


Figure B.3-6a: Central Body Control Torques vs. Time (Concept 1)

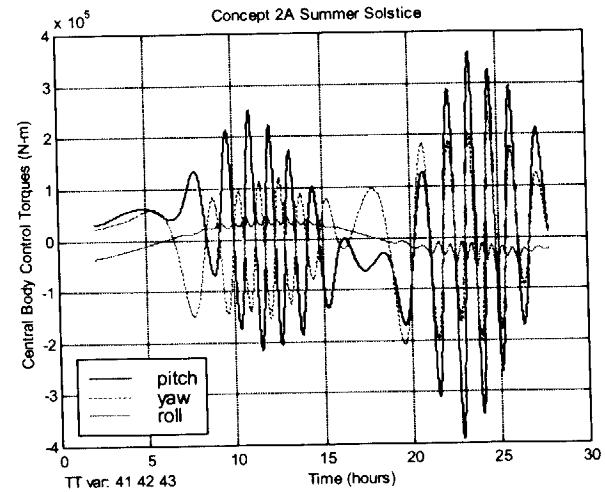


Figure B.3-6b: Central Body Control Torques vs. Time (Concept 2A)

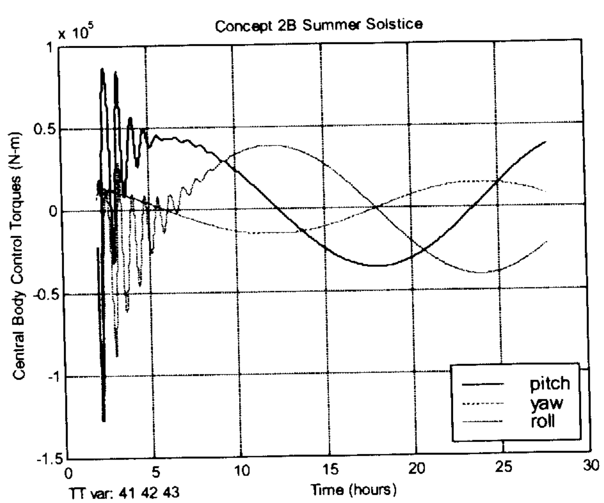


Figure B.3-6c: Central Body Control Torques vs. Time (Concept 2B)

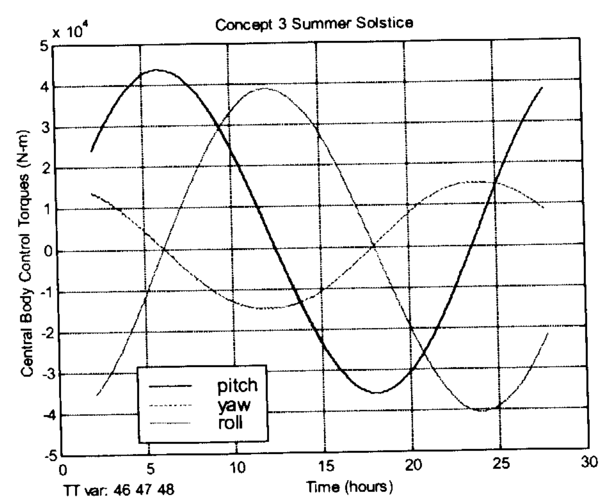


Figure B.3-6d: Central Body Control Torques vs. Time (Concept 3)

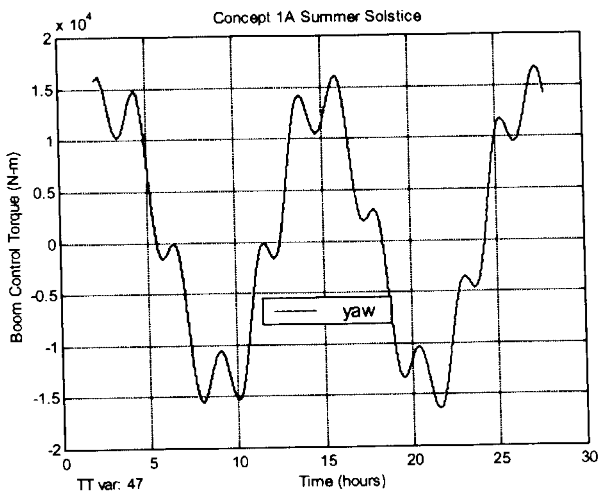


Figure B.3-7a: Boom Control Torques vs. Time
(Concept 1)

N/A

Figure B.3-7b: Boom Control Torques vs. Time
(Concept 2A)

N/A

Figure B.3-7c: Boom Control Torques vs. Time
(Concept 2B)

N/A

Figure B.3-7d: Boom Control Torques vs. Time
(Concept 3)

Not Used for Control in this concept

Figure B.3-8a: Upper Clamshell Control Torques vs. Time (Concept 1)

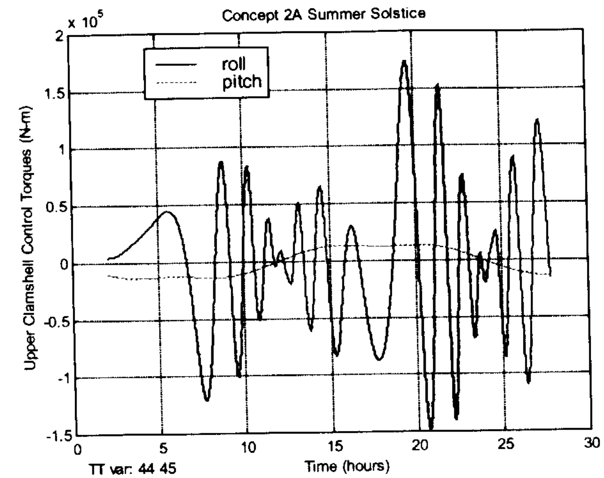


Figure B.3-8b: Upper Clamshell Control Torques vs. Time (Concept 2A)

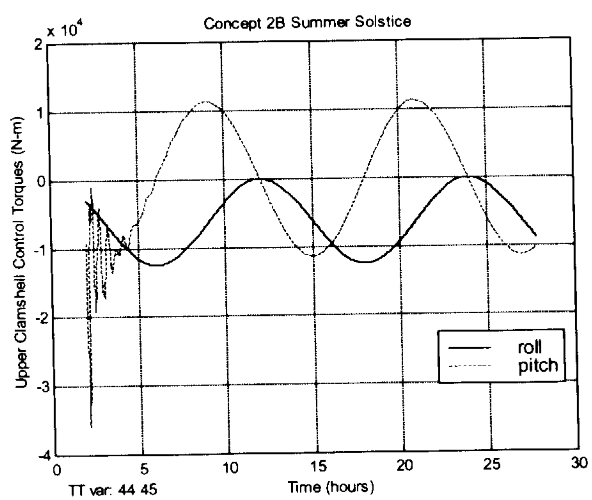


Figure B.3-8c: Upper Clamshell Control Torques vs. Time (Concept 2B)

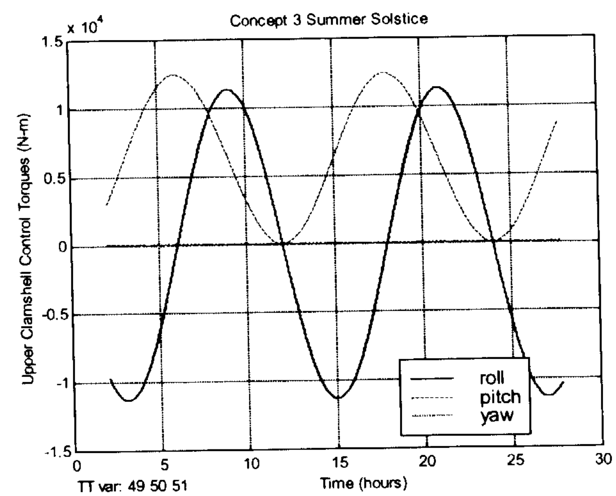


Figure B.3-8d: Upper Clamshell Control Torques vs. Time (Concept 3)

Not Used in Control

Figure B.3-9a: Lower Clamshell Control Torques vs. Time (Concept 1)

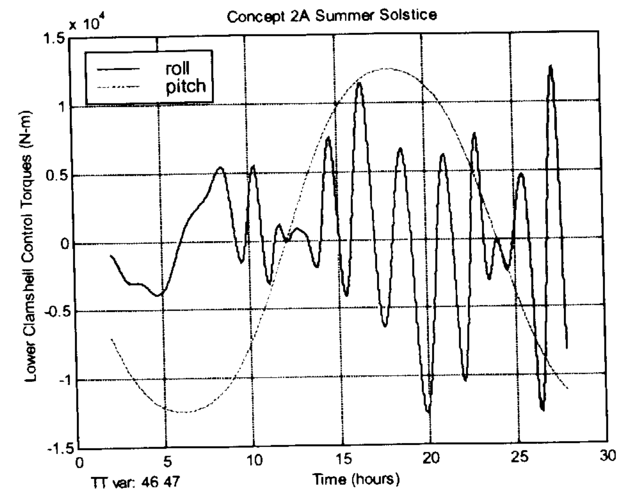


Figure B.3-9b: Lower Clamshell Control Torques vs. Time (Concept 2A)

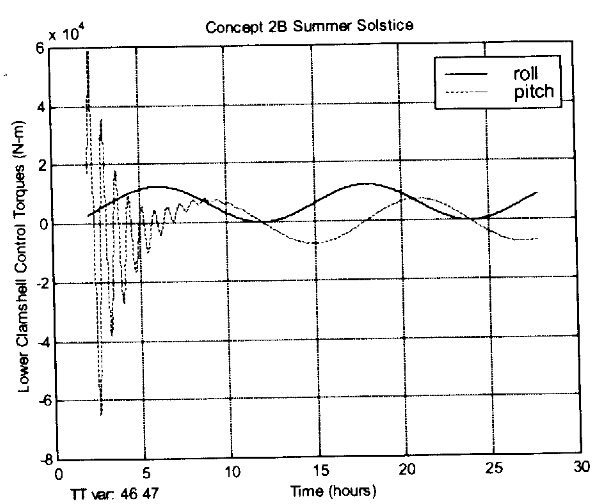


Figure B.3-9c: Lower Clamshell Control Torques vs. Time (Concept 2B)

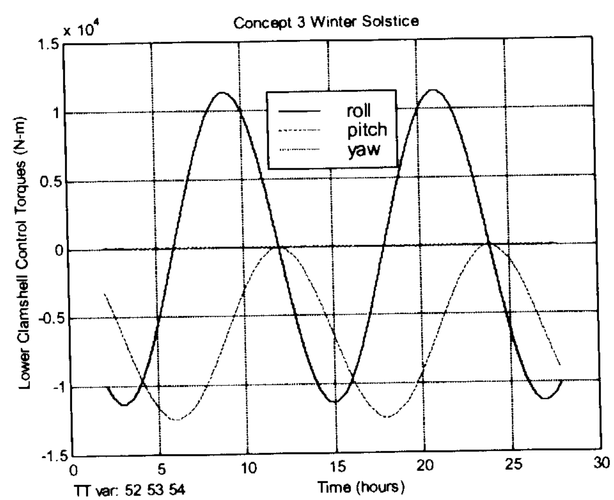


Figure B.3-9d: Lower Clamshell Control Torques vs. Time (Concept 3)

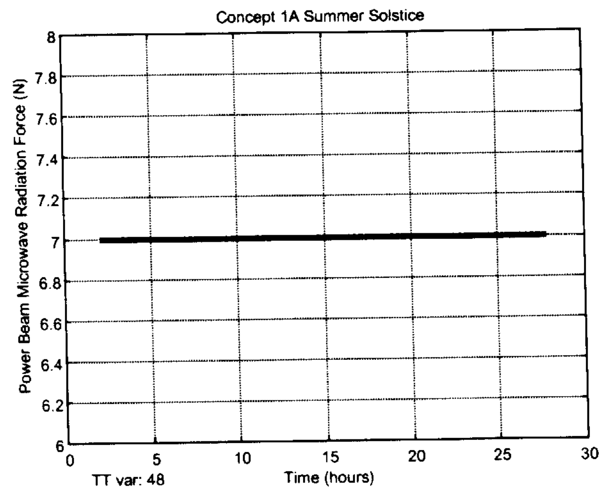


Figure B.3-10a: Power Beam Microwave Radiation Force vs. Time
(Concept 1)

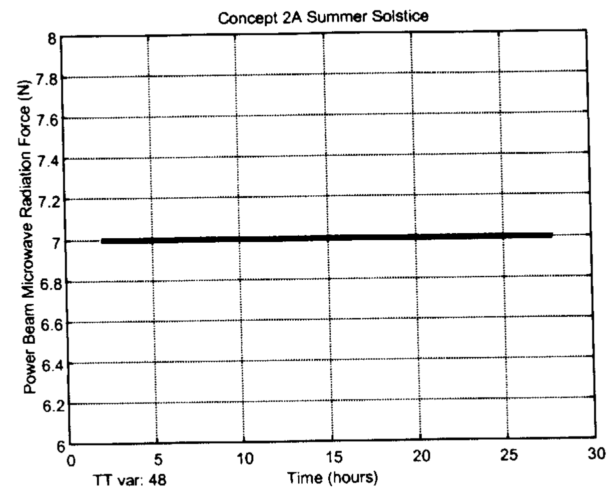


Figure B.3-10b: Power Beam Microwave Radiation Force
vs. Time
(Concept 2A)

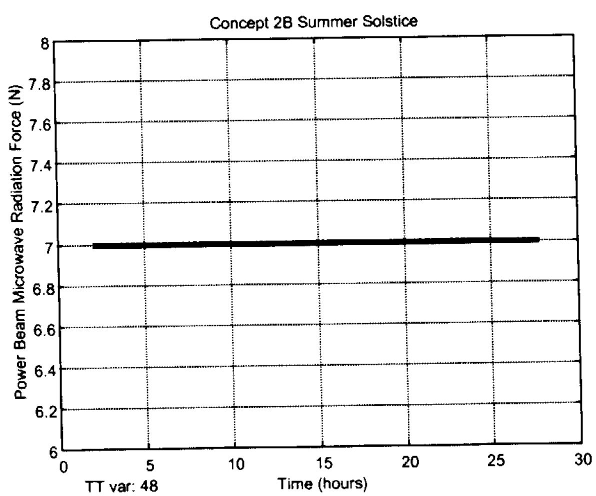


Figure B.3-10c: Power Beam Microwave Radiation Force
vs. Time
(Concept 2B)

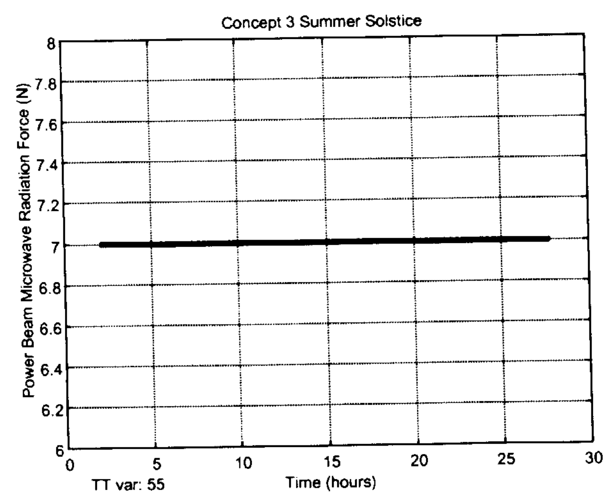


Figure B.3-10d: Power Beam Microwave Radiation Force
vs. Time
(Concept 3)

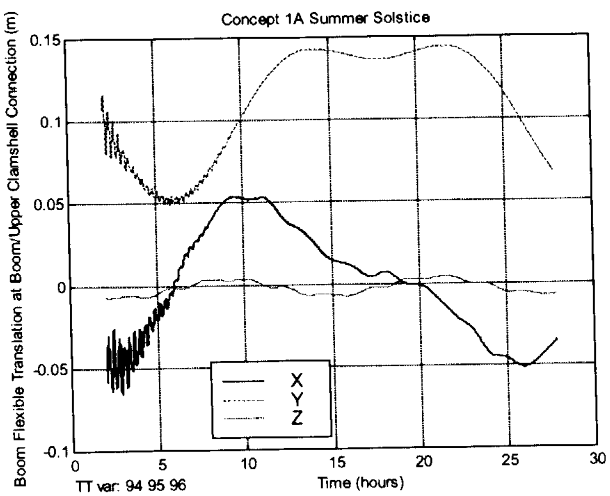


Figure B.3-11a: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Concept 1)

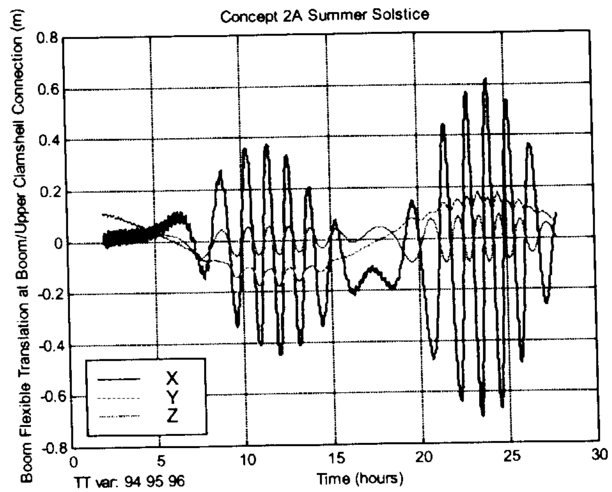


Figure B.3-11b: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Concept 2A)

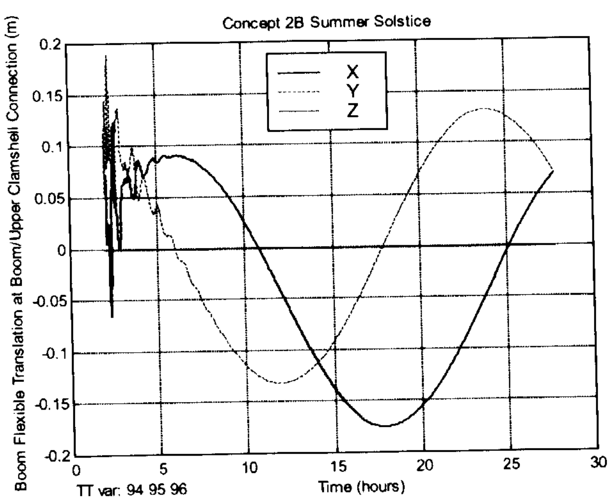


Figure B.3-11c: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Concept 2B)

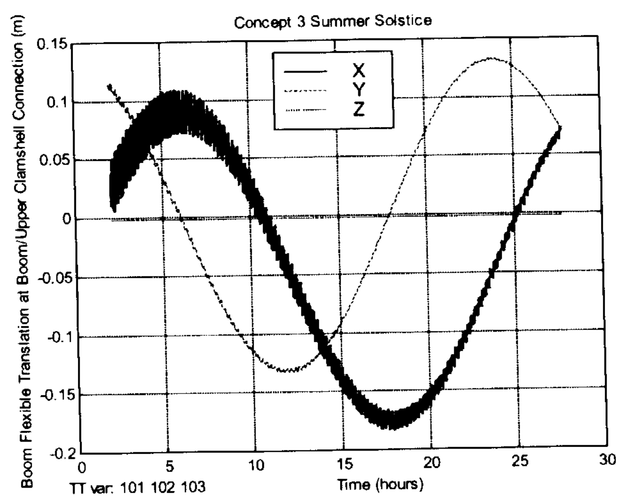


Figure B.3-11d: Boom Flexible Translation at Boom/Upper Clamshell Connection vs. Time (Concept 3)

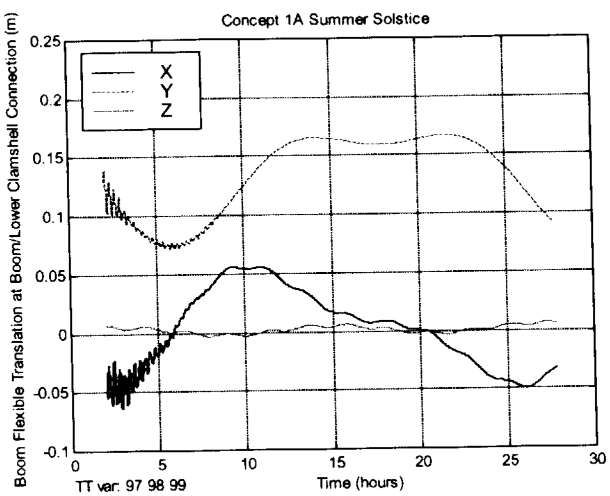


Figure B.3-12a: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Concept 1)

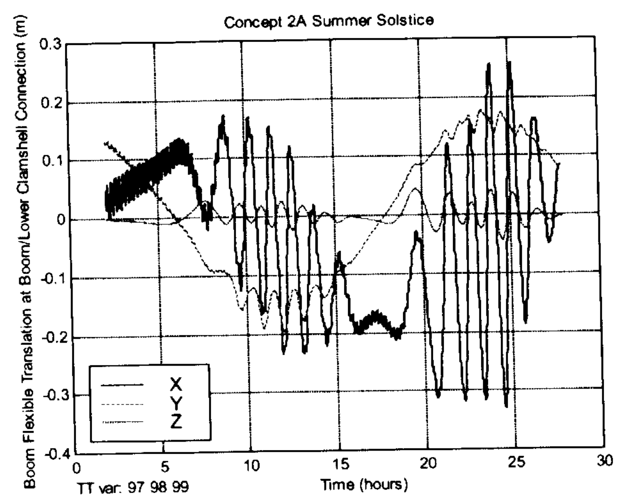


Figure B.3-12b: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Concept 2A)

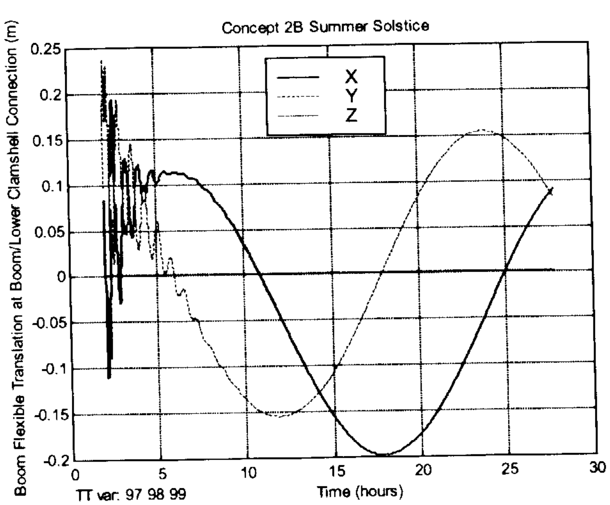


Figure B.3-12c: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Concept 2B)

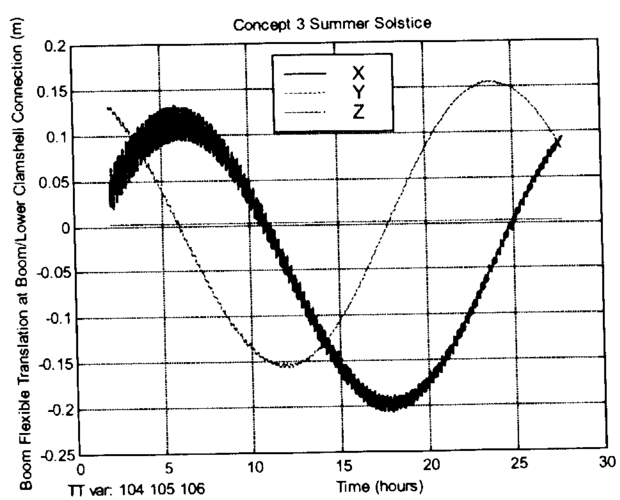


Figure B.3-12d: Boom Flexible Translation at Boom/Lower Clamshell Connection vs. Time (Concept 3)

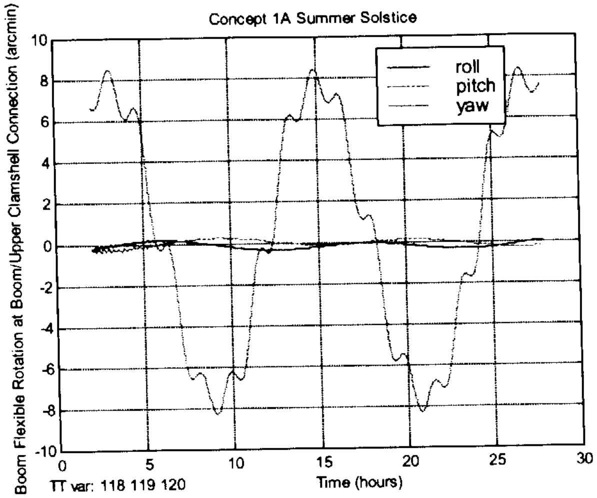


Figure B.3-13a: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Concept 1)

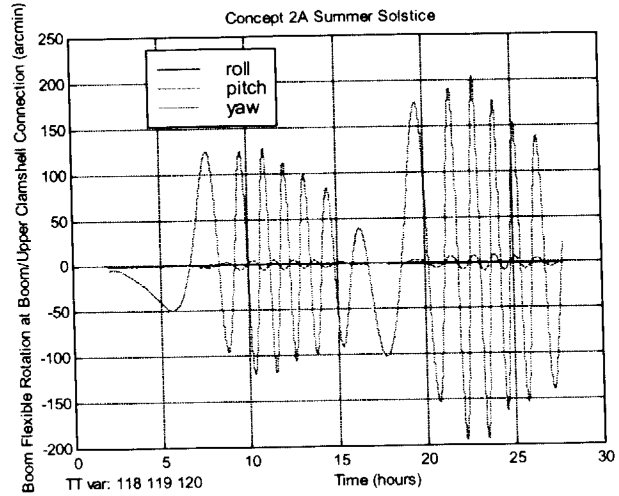


Figure B.3-13b: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Concept 2A)

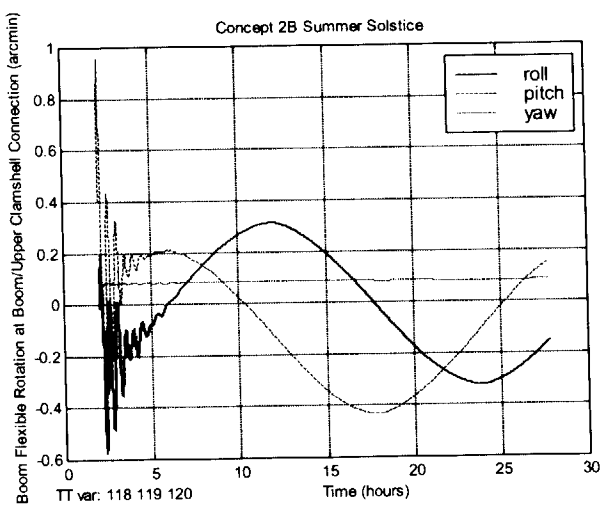


Figure B.3-13c: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Concept 2B)

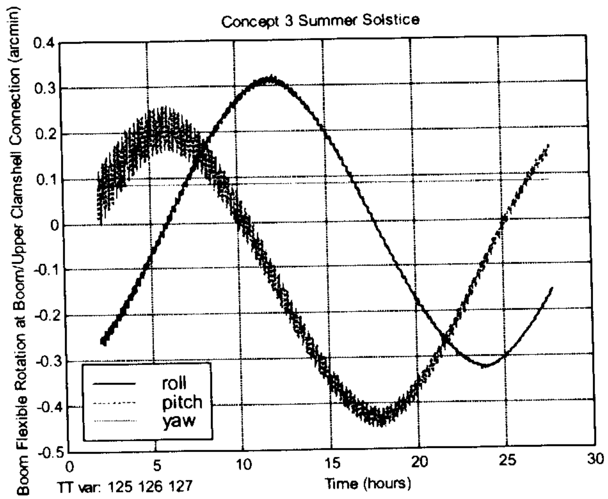


Figure B.3-13d: Boom Flexible Rotation at Boom/Upper Clamshell Connection vs. Time (Concept 3)

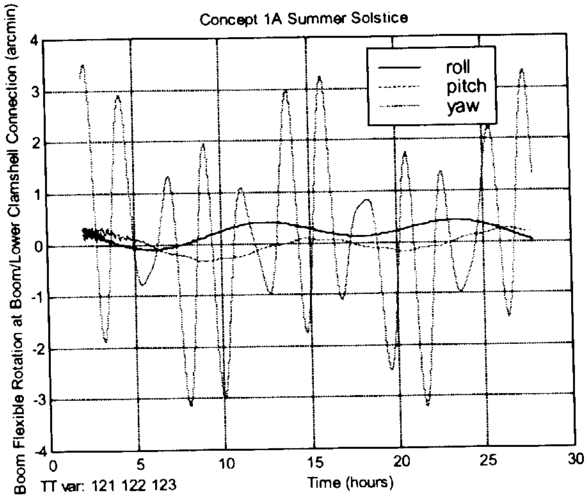


Figure B.3-14a: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Concept 1)

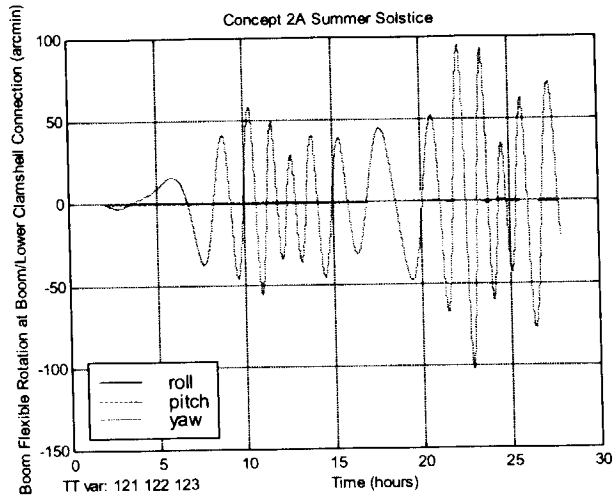


Figure B.3-14b: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Concept 2A)

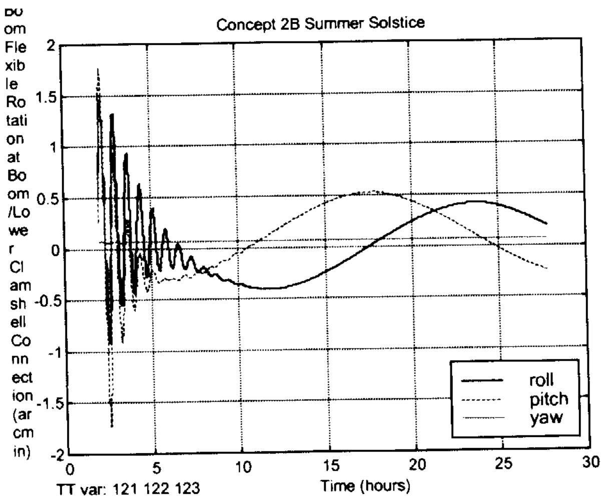


Figure B.3-14c: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Concept 2B)

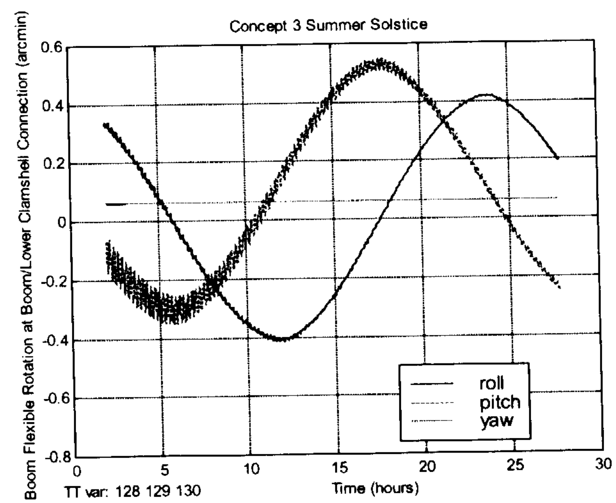


Figure B.3-14d: Boom Flexible Rotation at Boom/Lower Clamshell Connection vs. Time (Concept 3)

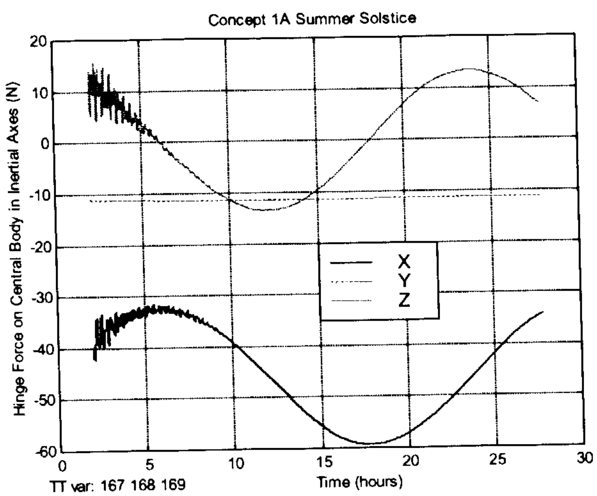


Figure B.3-15a: Hinge Force on Central Body in Inertial Axes vs. Time (Concept 1)

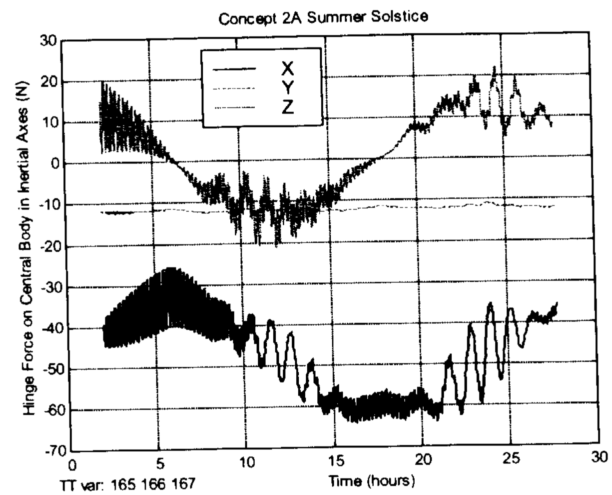


Figure B.3-15b: Hinge Force on Central Body in Inertial Axes vs. Time (Concept 2A)

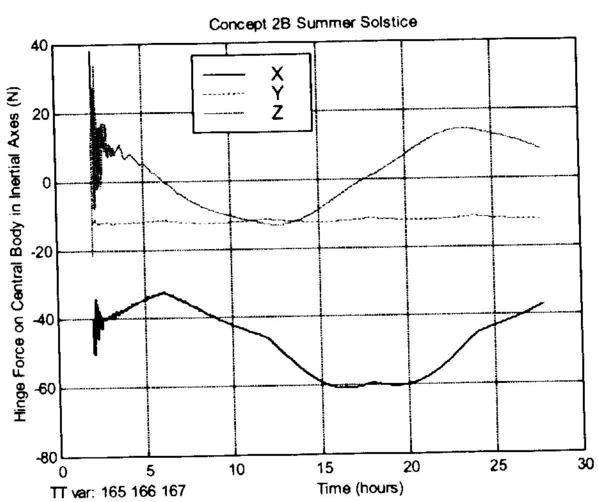


Figure B.3-15c: Hinge Force on Central Body in Inertial Axes vs. Time (Concept 2B)

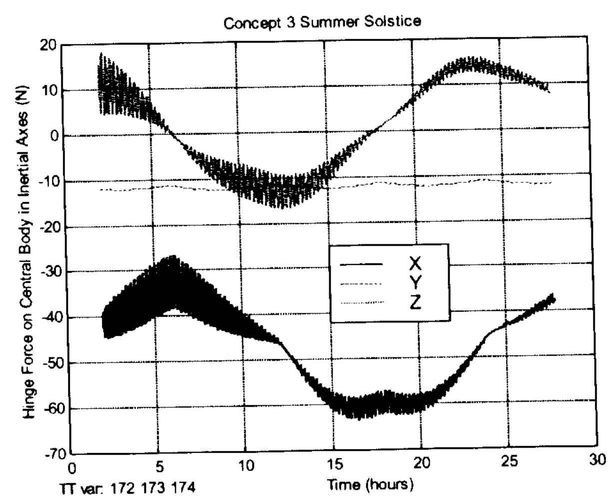


Figure B.3-15d: Hinge Force on Central Body in Inertial Axes vs. Time (Concept 3)

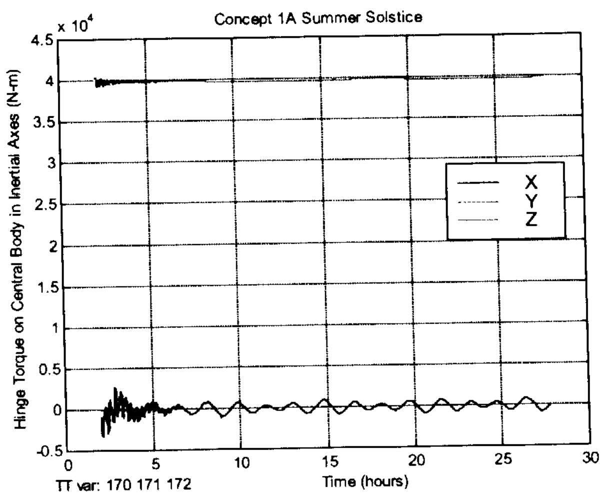


Figure B.3-16a: Hinge Torque on Central Body in Inertial Axes vs. Time (Concept 1)

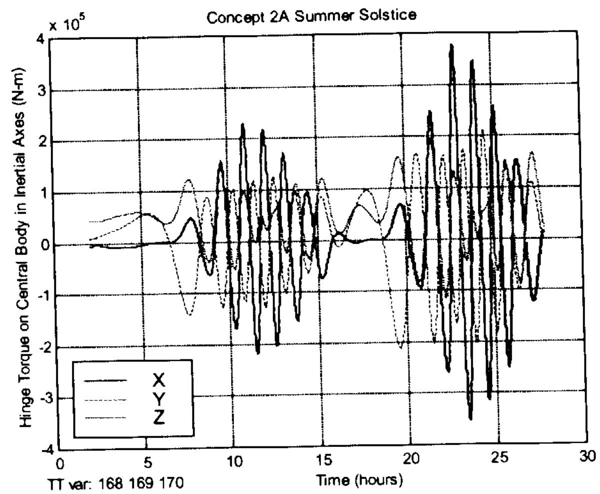


Figure B.3-16b: Hinge Torque on Central Body in Inertial Axes vs. Time (Concept 2A)

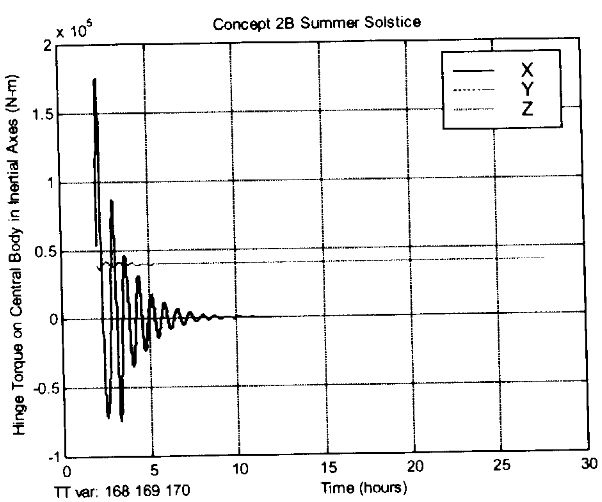


Figure B.3-16c: Hinge Torque on Central Body in Inertial Axes vs. Time (Concept 2B)

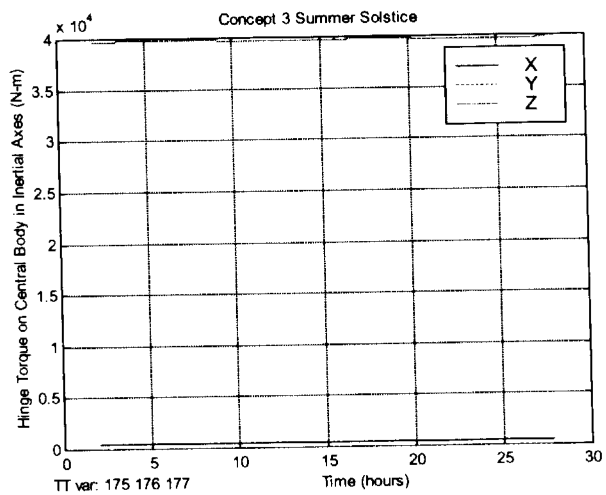


Figure B.3-16d: Hinge Torque on Central Body in Inertial Axes vs. Time (Concept 3)

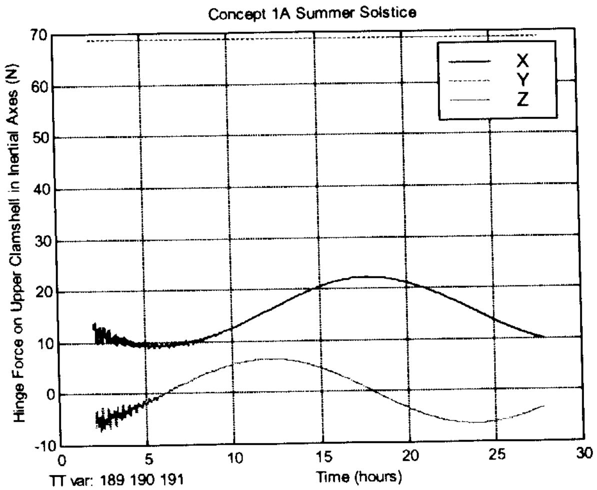


Figure B.3-17a: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Concept 1)

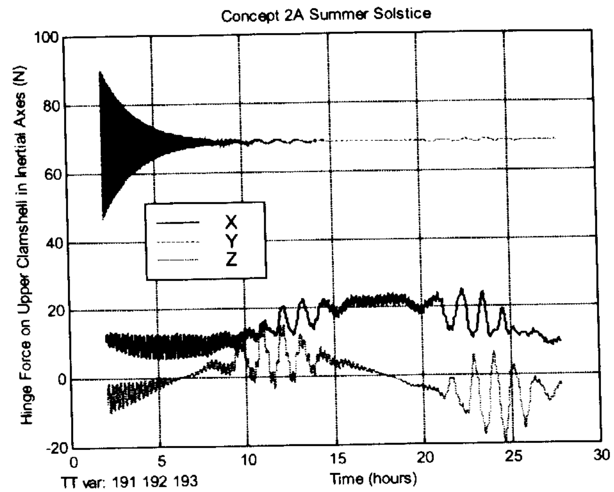


Figure B.3-17b: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Concept 2A)

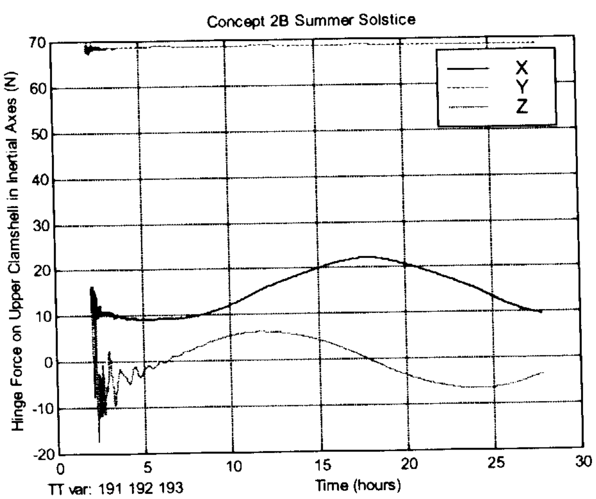


Figure B.3-17c: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Concept 2B)

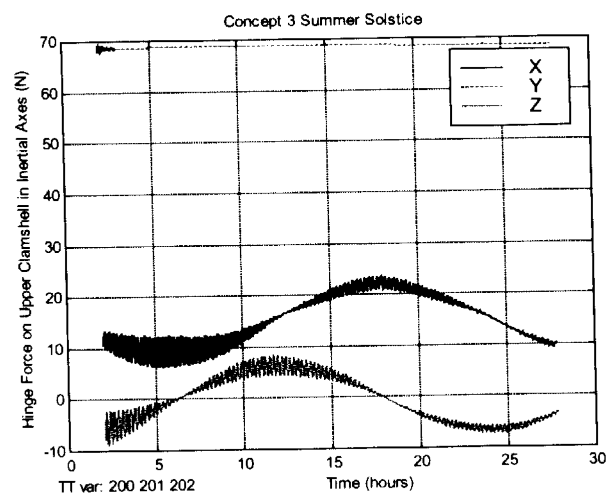


Figure B.3-17d: Hinge Force on Upper Clamshell in Inertial Axes vs. Time (Concept 3)

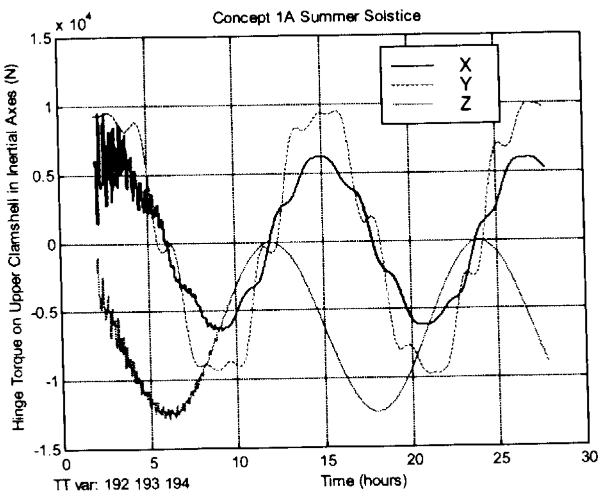


Figure B.3-18a: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Concept 1)

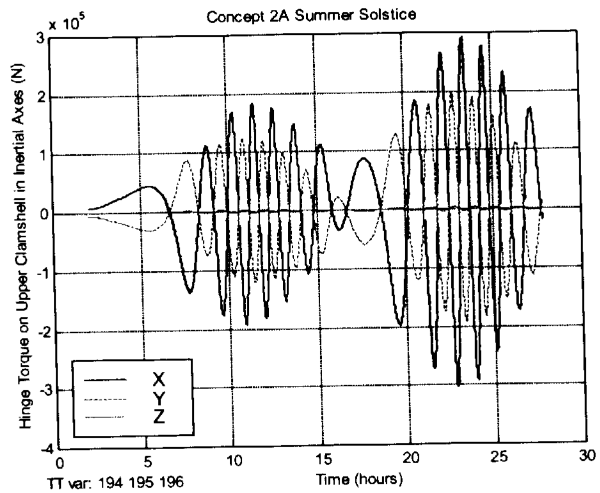


Figure B.3-18b: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Concept 2A)

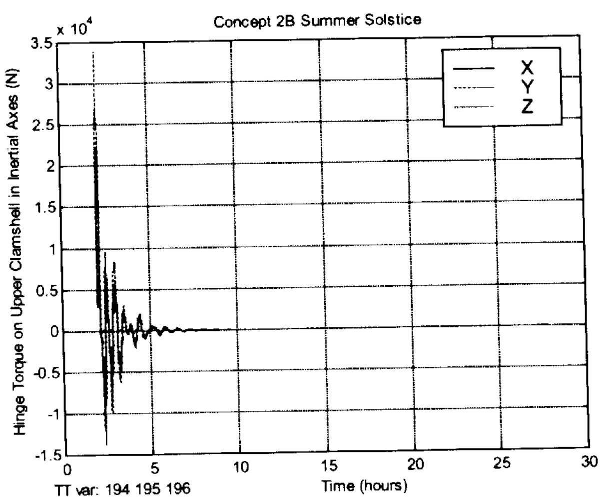


Figure B.3-18c: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Concept 2B)

Torque Curves are zero for Case 3

Figure B.3-18d: Hinge Torque on Upper Clamshell in Inertial Axes vs. Time (Concept 3)

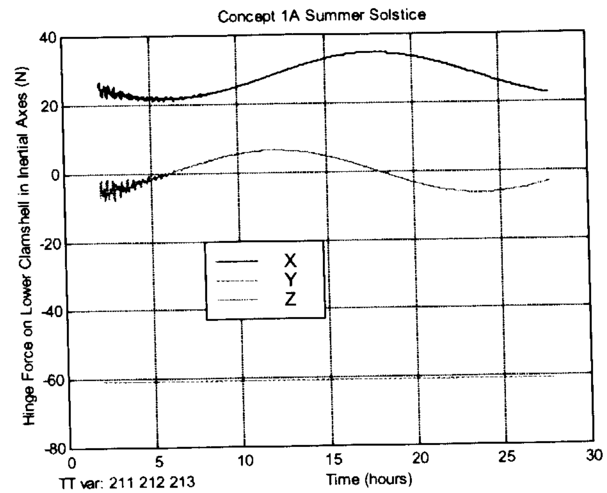


Figure B.3-19a: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Concept 1)

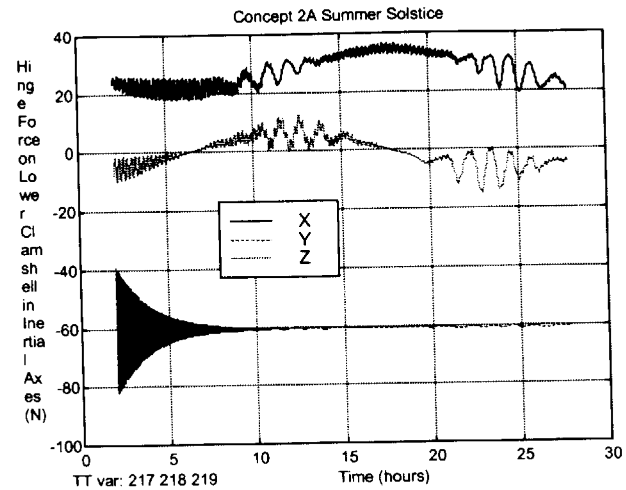


Figure B.3-19b: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Concept 2A)

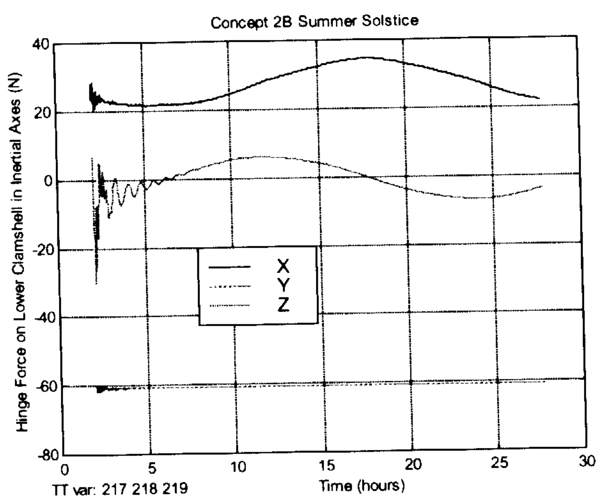


Figure B.3-19c: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Concept 2B)

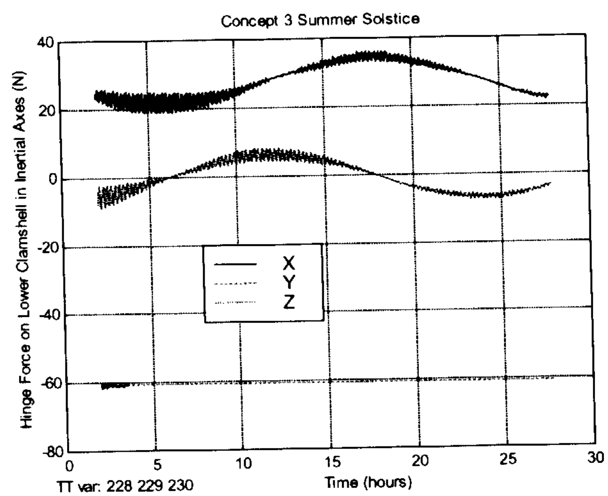


Figure B.3-19d: Hinge Force on Lower Clamshell in Inertial Axes vs. Time (Concept 3)

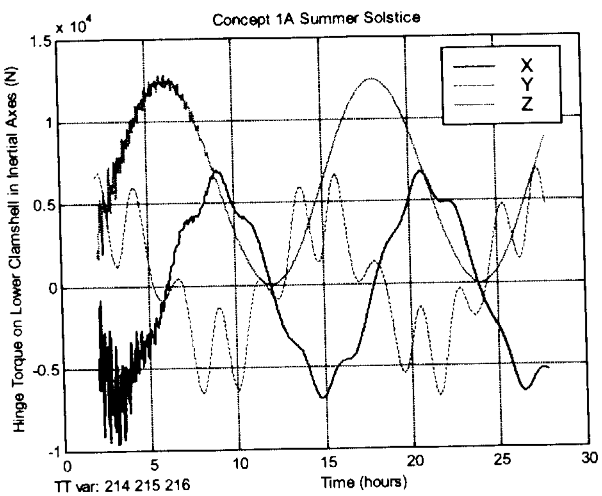


Figure B.3-20a: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Concept 1)

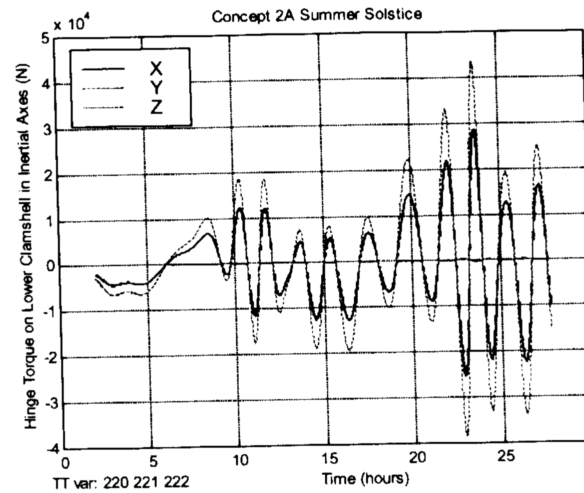


Figure B.3-20b: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Concept 2A)

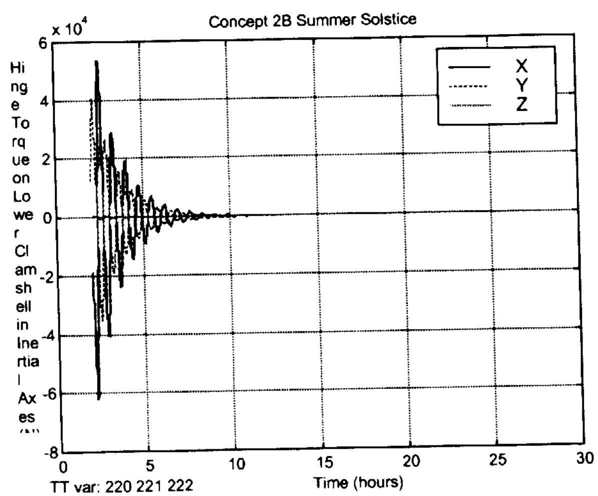


Figure B.3-20c: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Concept 2B)

Torque Curves are zero for Case 3

Figure B.3-20d: Hinge Torque on Lower Clamshell in Inertial Axes vs. Time (Concept 3)

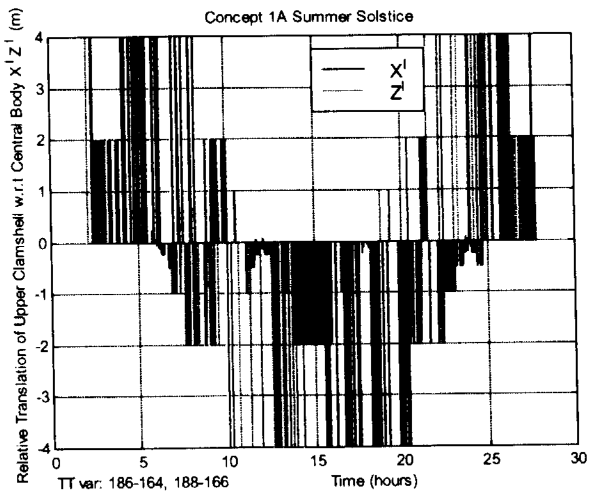


Figure B.3-21a: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Concept 1)

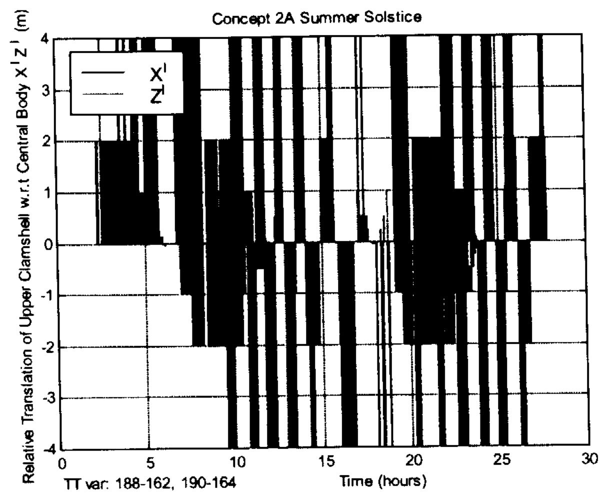


Figure B.3-21b: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Concept 2A)

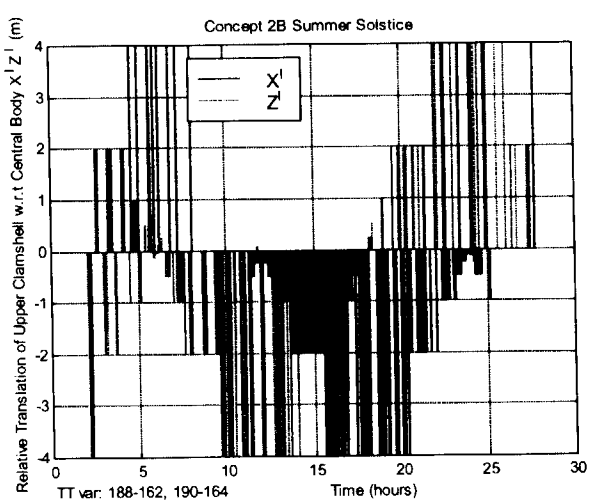


Figure B.3-21c: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Concept 2B)

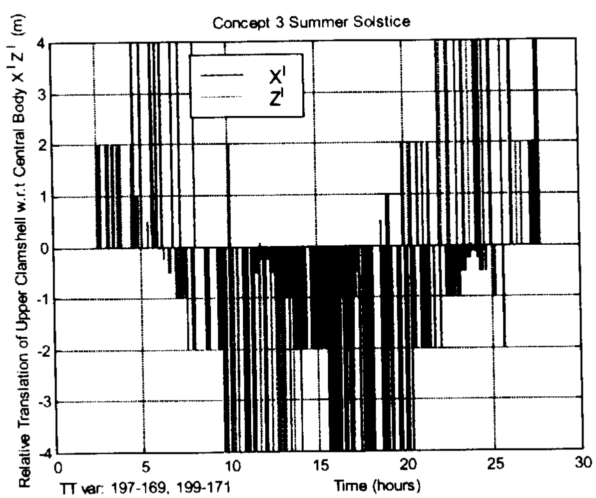


Figure B.3-21d: Relative Translation of Upper Clamshell w.r.t. Central Body vs. Time (Concept 3)

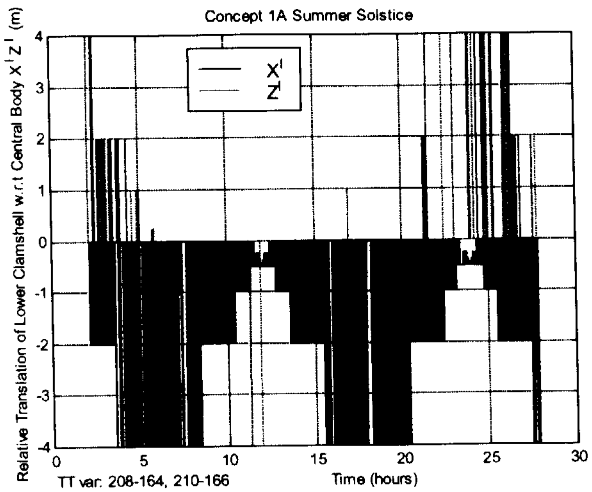


Figure B.3-22a: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Concept 1)

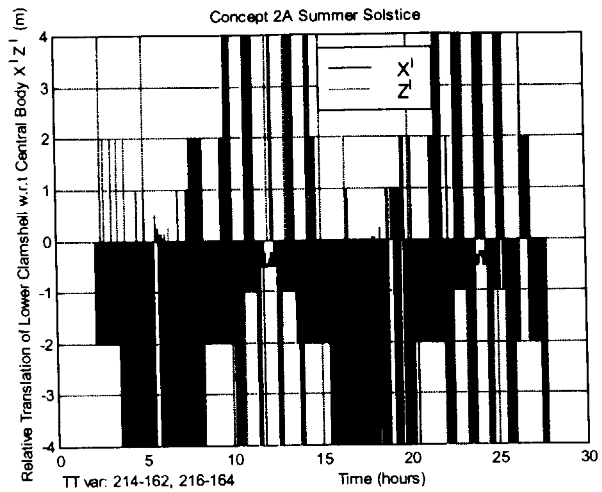


Figure B.3-22b: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Concept 2A)

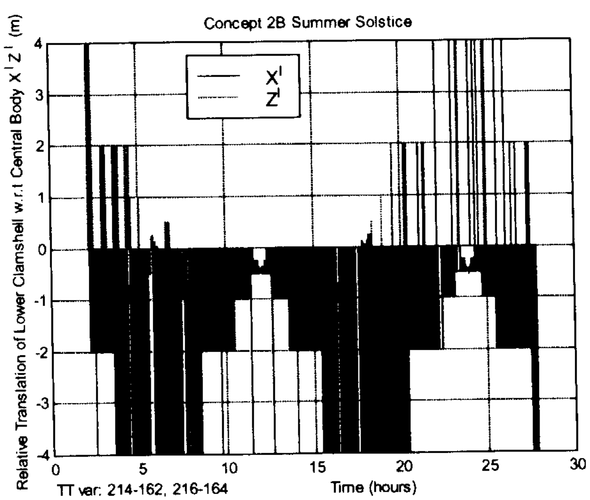


Figure B.3-22c: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Concept 2B)

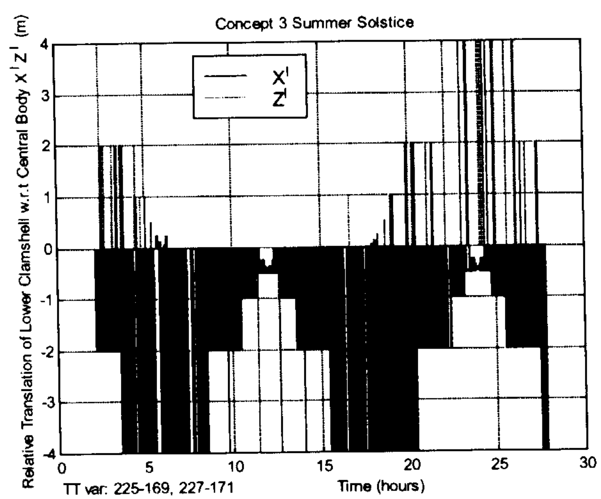


Figure B.3-22d: Relative Translation of Lower Clamshell w.r.t. Central Body vs. Time (Concept 3)

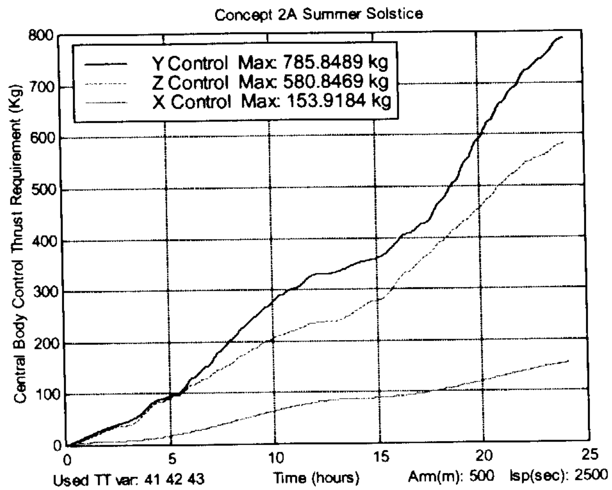


Figure B.3-23a: Central Body Control Thrust Requirement vs. Time for 1 Day
(Concept 2A)

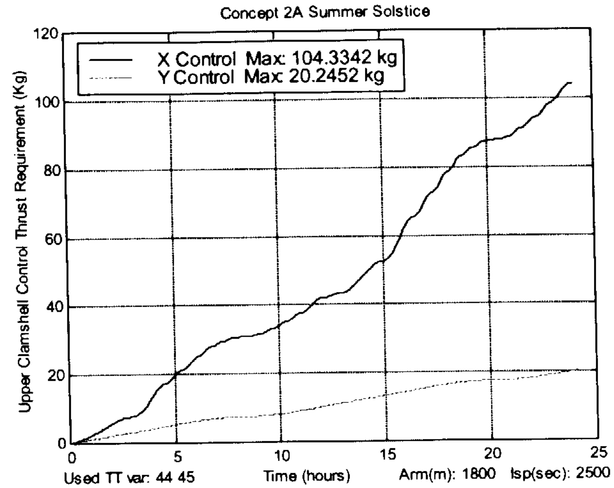


Figure B.3-23b: Upper Clamshell Control Thrust Requirement vs. Time for 1 Day
(Concept 2A)

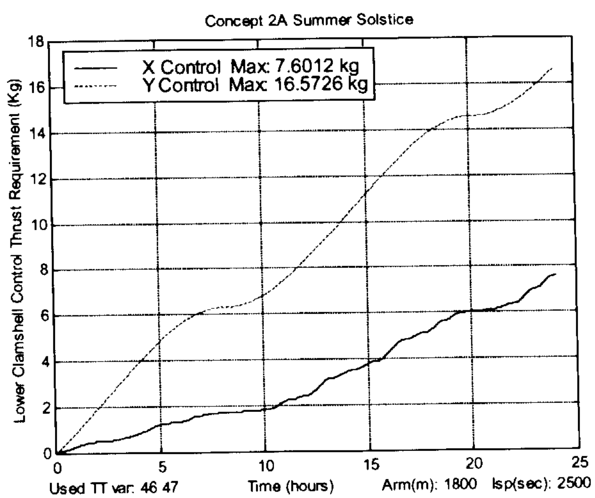


Figure B.3-23c: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day
(Concept 2A)

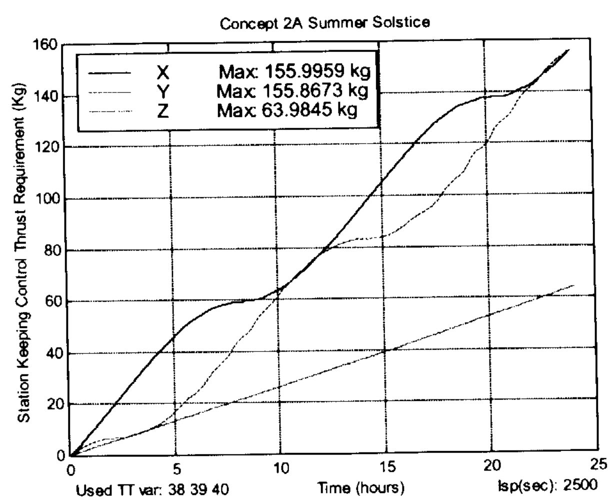


Figure B.3-23d: Station Keeping Control Thrust Requirement vs. Time for 1 Day
(Concept 2A)

Table B.3-1: Predicted Daily Thrust Requirements (Kg) (Concept 2A)

	Vernal Equinox (Est.)			Summer Solstice (Calc.)			Autumnal Equinox (Est.)			Winter Solstice (Est.)			Daily Average			Total
Description	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.4	12.6	640.4	153.918	785.849	580.847	4.8	23.2	641.5	153.9	785.1	580.7	79.005	401.687	610.862	1091.554
Upper Clamshell Control	88.4	22.0	--	104.334	20.245	--	88.8	22.0	--	68.5	20.24	--	87.509	21.121	--	108.63
Lower Clamshell Control	9.8	18.0	--	7.601	16.573	--	9.7	18.0	--	11.6	16.6	--	9.675	17.293	--	26.968
Total	101.6	52.6	640.4	265.853	822.667	580.847	103.3	63.2	641.5	234.	821.94	580.7	176.188	440.102	610.862	1227.152

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m; Total System Mass = 16921186.33 kg
2) Est. = Estimated using (Summer Solstice calc 2A/Summer Solstice calc 3)x(calc 3) for each case and component.

Table B.3-2: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 2A)

	Vernal Equinox (Est.)			Summer Solstice (Calc.)			Autumnal Equinox (Est)			Winter Solstice (Est)			Daily Average			Total
Description	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	169.5	172.1	.798	155.996	155.867	63.985	181.5	172.4	1.9	156.5	155.9	64.	165.874	164.067	32.670	362.612

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m; Total System Mass = 16921186.33 kg
2) Est. = Estimated using (Summer Solstice calc 2A/Summer Solstice calc 3)x(calc 3) for each case and component.

TABLE B.3-3: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 2A)

	Daily Total				Yearly Total			
Description	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control	Total (1 Year)
Central Body Control	79.005	401.687	610.862	1091.554	28857.	146716.	223117.	398690.
Upper Clamshell Control	87.509	21.121	--	108.630	31963.	7714.	--	39677.
Lower Clamshell Control	9.675	17.293	--	26.968	3534.	6316.	--	9850.
Total	176.188	440.102	610.862	1227.152	64353.	160747.	223117	448217.

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m
2) 1 Year = 365.25 days

TABLE B.3-4: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 2A)

	Daily Total				Yearly Total			
Description	X	Y	Z	Total (1 Day)	X	Y	Z	Total (1 Year)
Station Keeping Control	165.874	164.067	32.670	362.611	60585.	59925.	11933.	132443.

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) 1 Year = 365.25 days

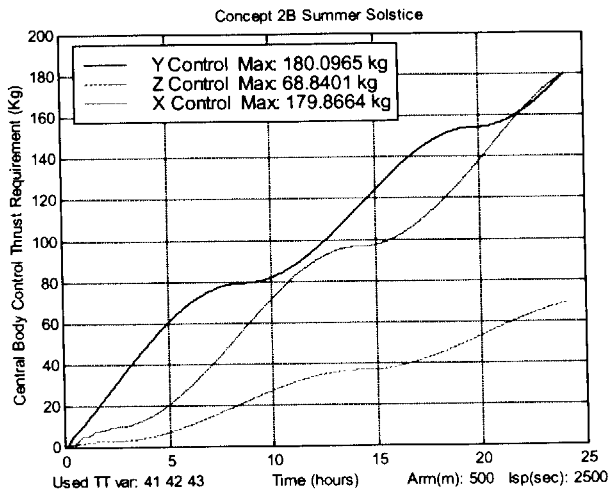


Figure B.3-24a: Central Body Control Thrust Requirement vs. Time for 1 Day
(Concept 2B)

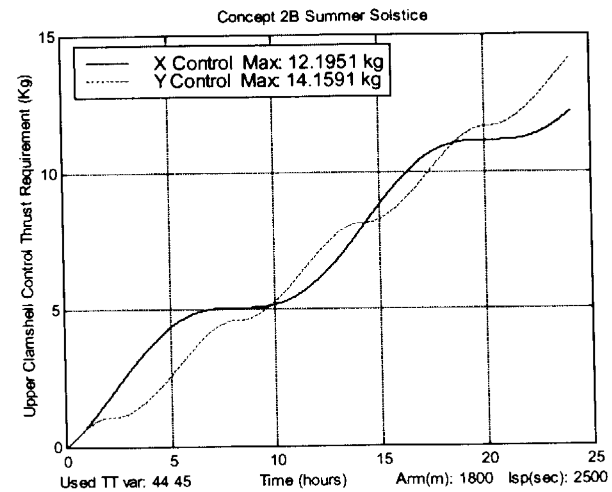


Figure B.3-24b: Upper Clamshell Control Thrust Requirement vs. Time for 1 Day
(Concept 2B)

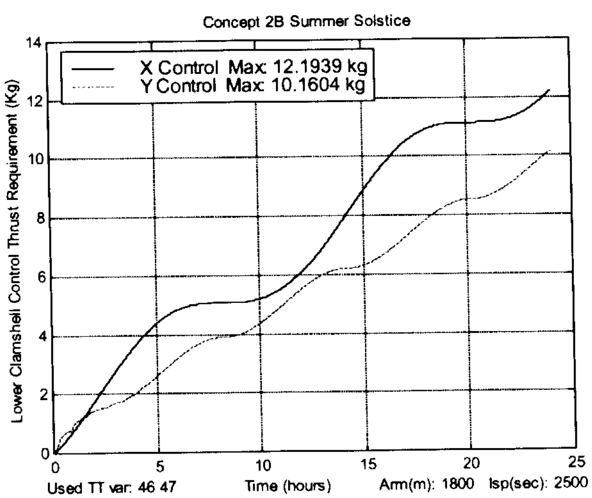


Figure B.3-24c: Lower Clamshell Control Thrust Requirement vs. Time for 1 Day
(Concept 2B)

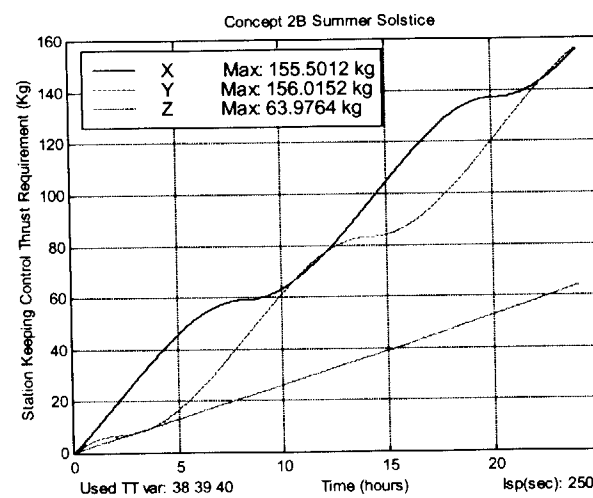


Figure B.3-24d: Station Keeping Control Thrust Requirement vs. Time for 1 Day
(Concept 2B)

Table B.3-5: Predicted Daily Thrust Requirements (Kg) (Concept 2B)

	Vernal Equinox (Est.)			Summer Solstice (Calc.)			Autumnal Equinox (Est.)			Winter Solstice (Est.)			Daily Average			Total
Description	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	X Control	Y Control	Z Control	
Central Body Control	3.9	2.9	75.9	179.866	180.100	68.840	5.6	5.3	76.0	179.8	180.0	68.8	92.292	92.075	72.385	256.752
Upper Clamshell Control	10.3	15.4	--	12.195	14.159	--	10.4	15.4	--	8.0	14.2	--	10.224	14.790	--	25.014
Lower Clamshell Control	15.7	11.0	--	12.194	10.160	--	15.6	11.0	--	18.6	10.2	--	15.524	10.590	--	26.114
Total	29.9	29.3	75.9	204.255	204.419	68.840	31.6	31.7	76.0	206.4	204.4	68.8	118.04	117.455	72.385	307.880

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m
2) Est. = Estimated using (Summer Solstice calc 2B/Summer Solstice calc 3)x(calc 3) for each case and component.

Table B.3-6: Predicted Daily Thrust Requirements (Kg) for Station Keeping (Concept 2B)

	Vernal Equinox (Est.)			Summer Solstice (Calc.)			Autumnal Equinox (Est.)			Winter Solstice (Est.)			Daily Average			Total
Description	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	
Station Keeping Control	168.9	172.3	.798	155.501	156.015	63.976	181.0	172.5	1.863	156.0	156.0	63.976	165.350	164.203	32.653	362.206

Notes:
1) Assumptions: Isp = 2500. Sec; Total System Mass = 16921186.33 kg
2) Est. = Estimated using (Summer Solstice calc 2B/Summer Solstice calc 3)x(calc 3) for each case and component.

TABLE B.3-7: Predicted Daily and Yearly Thrust Requirements (Kg) (Concept 2B)

	Daily Total				Yearly Total			
Description	X Control	Y Control	Z Control	Total (1 Day)	X Control	Y Control	Z Control	Total (1 Year)
Central Body Control	92.292	92.075	72.385	256.752	33710.	33630.	26439.	93779.
Upper Clamshell Control	10.224	14.790	--	25.014	3734.	5402.	--	9136.
Lower Clamshell Control	15.524	10.590	--	26.114	5670.	3868.	--	9538.
Total	118.040	117.455	72.385	307.880	43114.	42900.	26439.	112453.

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m; Total System Mass = 16921186.33 kg
2) 1 Year = 365.25 days

TABLE B.3-8: Predicted Daily and Yearly Thrust Requirements for Station Keeping (Kg) (Concept 2B)

	Daily Total				Yearly Total			
Description	X	Y	Z	Total (1 Day)	X	Y	Z	Total (1 Year)
Station Keeping Control	165.350	164.203	32.653	362.206	60394.	59975.	11927.	132296.

Notes:
1) Assumptions: Isp = 2500. Sec; Thrusters moment arm on Central Body = 500 m, Upper Clamshell = 1800 m, Lower Clamshell = 1800 m; Total System Mass = 16921186.33 kg
2) 1 Year = 365.25 days

B.4 -Thrust Requirements Comparison for Concept 1, Concept 2A, Concept 2B, Concept 3 and Stationkeeping

Table B.4-1:
Predicted Thrust Requirements for Concept 1, Concept 2A, Concept 2B, Concept 3 and Stationkeeping

Description	Daily Total					Est. Annual Total
	VE	SS	AE	WS	ave	ave x 365.25
C1	97.27	439.988	101.44	439.74	269.610	98475.
C2A	794.6	1669.367	808.0	1636.64	1227.152	448217.
C2B	135.1	477.514	139.3	479.6	307.880	112453.
C3	133.125	474.016	137.317	473.806	304.566	111243.
Stationkeeping C1	389.462	414.980	400.078	415.384	404.976	147917.
Stationkeeping C2A	342.398	375.848	355.800	376.400	362.612	132444.
Stationkeeping C2B	341.998	375.492	355.363	375.976	362.207	132296.
Stationkeeping C3	342.133	375.580	355.441	376.125	362.320	132337.

Notes:
1) Control based on predictions in tables B.1-5 (for C1), B.3-1 (for C2A), B.3-5 (for C2B) and B.2-1 (for C3)
2) Stationkeeping baseed on predictions in tables B.1-6 (for C1), B.3-2 (for C2A), B.3-6 (for C2B) and B.2-2 (C3).

Appendix C

System Natural Frequencies

TREETOPS model system natural frequencies for the SSP ISC Configuration for concept 1, concept 2A, concept 2B and concept 3 are given herein. (Set the Z option in TREETOPS to obtain .MDK matrix.)

The steps to determine system natural frequencies are as follows:

1) set the Z option in TREETOPS and set to short run time
2) run TREETOPS
3) edit .MDK file and determine number of dof
4) edit run_read_m_d_k.m and update dof
5) run_read_m_d_k in MATLAB
6) run eig2 to determine frequencies and mode shapes.

System Natural Frequencies (for Open Loop System) (Concept 1) (Hz):
(6 Rigid Body of System X, Y, Z, Roll, Pitch, Yaw)
(1 Rotations Free at Boom - Yaw)

1	0.0000000	
2	0.0000000	
3	0.0000000	
4	0.0000000	
5	0.0000000	
6	0.0000000	
7	0.0000000	
8	0.0001656	torsion
9	0.0009284	
10	0.0010580	
11	0.0012894	bending
12	0.0014804	bending
13	0.0016188	
14	0.0018034	
15	0.0046267	
16	0.0066675	
17	0.0207451	
18	0.0257265	
19	0.0289167	
20	0.0440772	
21	0.0441270	
22	0.0454749	
23	0.0456797	
24	0.0549901	
25	0.0831593	
26	0.3579221	
27	0.3604716	
28	0.5588000	
29	0.5588353	
30	0.5750994	
31	0.5751568	

System Natural Frequencies (for Open Loop System) (Concept 2A) (Hz):
(6 Rigid Body of System X, Y, Z, Roll, Pitch, Yaw)
(2 Rotations Free at UC - Roll, Pitch)
(2 Rotations Free at LC - Roll, Pitch)

1	0.0000000	
2	0.0000000	
3	0.0000000	
4	0.0000000	
5	0.0000000	
6	0.0000000	
7	0.0000000	
8	0.0000000	
9	0.0000000	
10	0.0000000	
11	0.0002136	torsion
12	0.0003722	torsion
13	0.0012078	bending
14	0.0013254	bending
15	0.0045433	
16	0.0065539	
17	0.0228855	
18	0.0288667	
19	0.0426760	
20	0.0428621	
21	0.0439833	
22	0.0443653	
23	0.0530351	
24	0.0585215	
25	0.1828217	
26	0.3348567	
27	0.3590667	
28	0.3606646	
29	0.4821389	
30	0.4986634	
31	0.5682767	
32	0.5904600	
33	0.7300594	
34	0.7300973	

System Natural Frequencies (for Open Loop System) (Concept 2B) (Hz):
(6 Rigid Body of System X, Y, Z, Roll, Pitch, Yaw)
(2 Rotations Free at UC - Yaw, Roll)
(2 Rotations Free at LC - Yaw, Roll)

1	0.0000000	
2	0.0000000	
3	0.0000000	
4	0.0000000	
5	0.0000000	
6	0.0000000	
7	0.0000000	
8	0.0000000	
9	0.0000000	
10	0.0000000	
11	0.0009283	
12	0.0012884	bending
13	0.0013167	bending
14	0.0016190	
15	0.0046238	
16	0.0065571	
17	0.0210080	
18	0.0219939	
19	0.0269741	
20	0.0297571	
21	0.0428616	
22	0.0440796	
23	0.0443568	
24	0.0454910	
25	0.0869754	
26	0.0914758	
27	0.3583247	
28	0.3605240	
29	0.4821389	
30	0.4986634	
31	0.5588121	
32	0.5751222	
33	0.7300594	
34	0.7300973	

System Natural Frequencies (for Open Loop System) (Concept 3) (Hz):

(6 Rigid Body of System X, Y, Z, Roll, Pitch, Yaw)
(3 Rotations Free at UC - Roll, Pitch, Yaw)
(3 Rotations Free at LC - Roll, Pitch, Yaw)

1	0.0000000	
2	0.0000000	
3	0.0000000	
4	0.0000000	
5	0.0000000	
6	0.0000000	
7	0.0000000	
8	0.0000000	
9	0.0000000	
10	0.0000000	
11	0.0000000	
12	0.0000000	
13	0.0012026	bending
14	0.0013171	bending
15	0.0045391	
16	0.0065538	
17	0.0210080	
18	0.0219932	
19	0.0269741	
20	0.0297506	
21	0.0428128	
22	0.0428639	
23	0.0441620	
24	0.0443726	
25	0.0869754	
26	0.0914758	
27	0.3583247	
28	0.3605240	
29	0.4821095	
30	0.4821525	
31	0.4986138	
32	0.4986909	
33	0.7300591	
34	0.7300594	
35	0.7300963	
36	0.7300973	

[Note: If The Upper and Lower Clamshell Rotations were fixed to the boom and all the mass moment of inertia of the clamshells were reacting against the boom, then the first natural frequency would be significantly lower:

f7= .000165 Hz Torsion UC and LC in opposite directions
f8= .000342 Hz Torsion UC and LC in one direction, CB in the other
f9= .000930 Hz
f10= .00106 Hz
f11= .00129 Hz bending
f12= .00148 Hz bending

(based on NASTRAN K123456 at UC and LC)]

Appendix D

A NASTRAN Model Description of the Boom

A NASTRAN model description for the boom for the SSP ISC is given herein. A brief synopsis is provided. NASTRAN data files have been provided with the technical data package.

The NASTRAN boom only model is defined using the following files:

ssp5_boom_sf_ng_13loc_dy_aset.dat (Boom Normal Modes Run)
include: ssp5_boom_top_sf.dat
include: ssp5_boom_bot_sf.dat
include: ssp5_connection_main_boom_top_13loc_a.dat
include: ssp5_connection_main_boom_bot_13loc_a.dat

The model is in metric SI units: length=meters(m), mass=kg, force=Newtons, time=seconds. The NASTRAN Basic CS origin is at the intersection of the Boom vertical centerline and the Central Body. The NASTRAN Basic CS axes are: +x is in the direction of the power beam and perpendicular to z axis, +y is RHR, +z along boom centerline toward upper boom (North).

A representation of the SSP ISC Boom modeled in NASTRAN is given in Figures D.1 through D.4.

An excerpt of the top and bottom NASTRAN .dat files are provided for property and material definitions.

Boom only mass properties and boom normal mode frequencies are presented.

Static load deflections are given for the upper end of the upper boom that is fixed at the boom center (assume boom fixed at boom/central body interface) and for a boom that is loaded at the upper end.

Results for full-up verification analysis including a flexible boom with the central body and clamshell mass and inertia are also presented. Specifically, mass and normal mode frequencies are given for two cases:

Full-Up System Verification K123 (Clamshell Rotations Free - Roll, Pitch, Yaw)
Full-Up System Verification K123456 (Clamshell Rotations Fixed to Boom)

Clamshell orientation for the full-up verification model is given in Figure D.5.

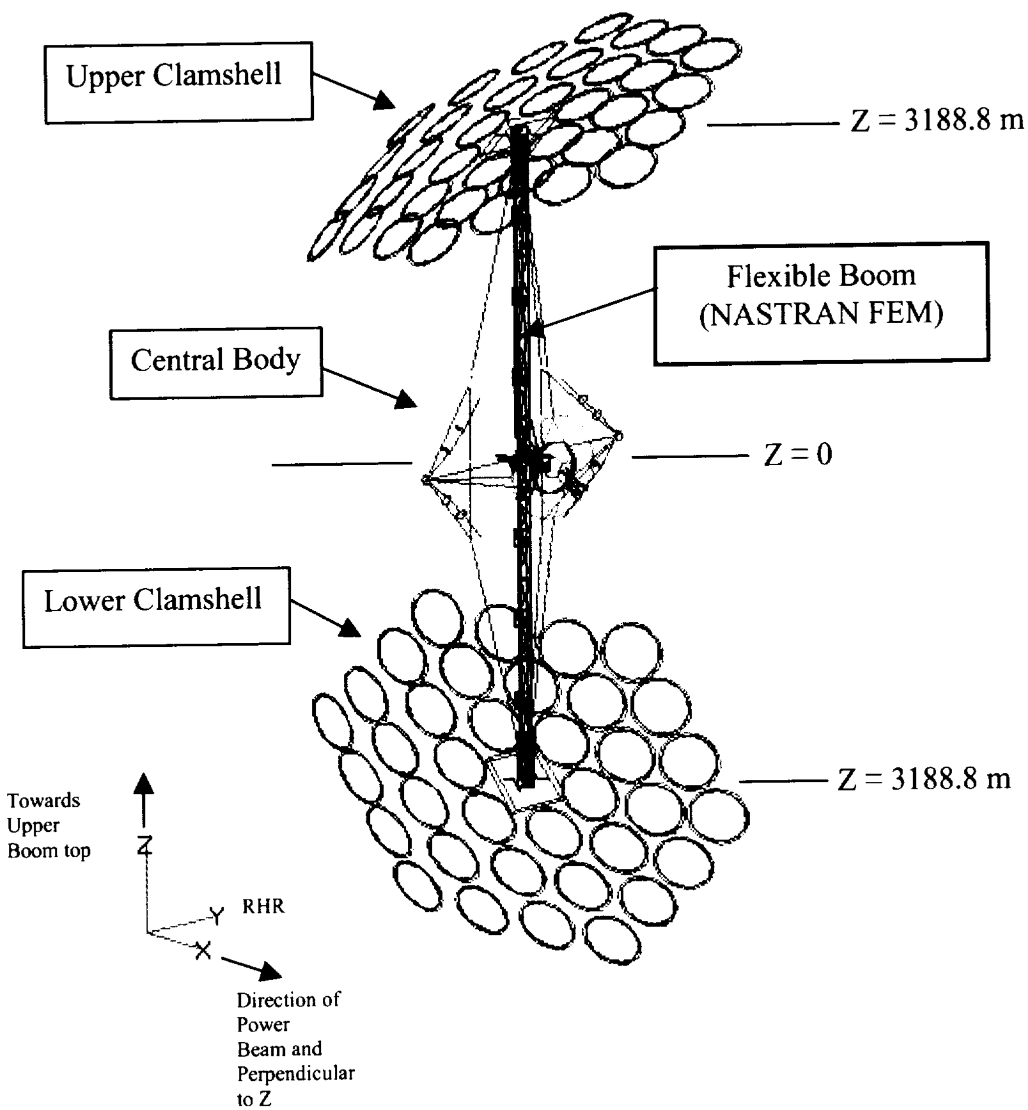


Figure D.1: SSP ISC Concept with NASTRAN Flexible Boom

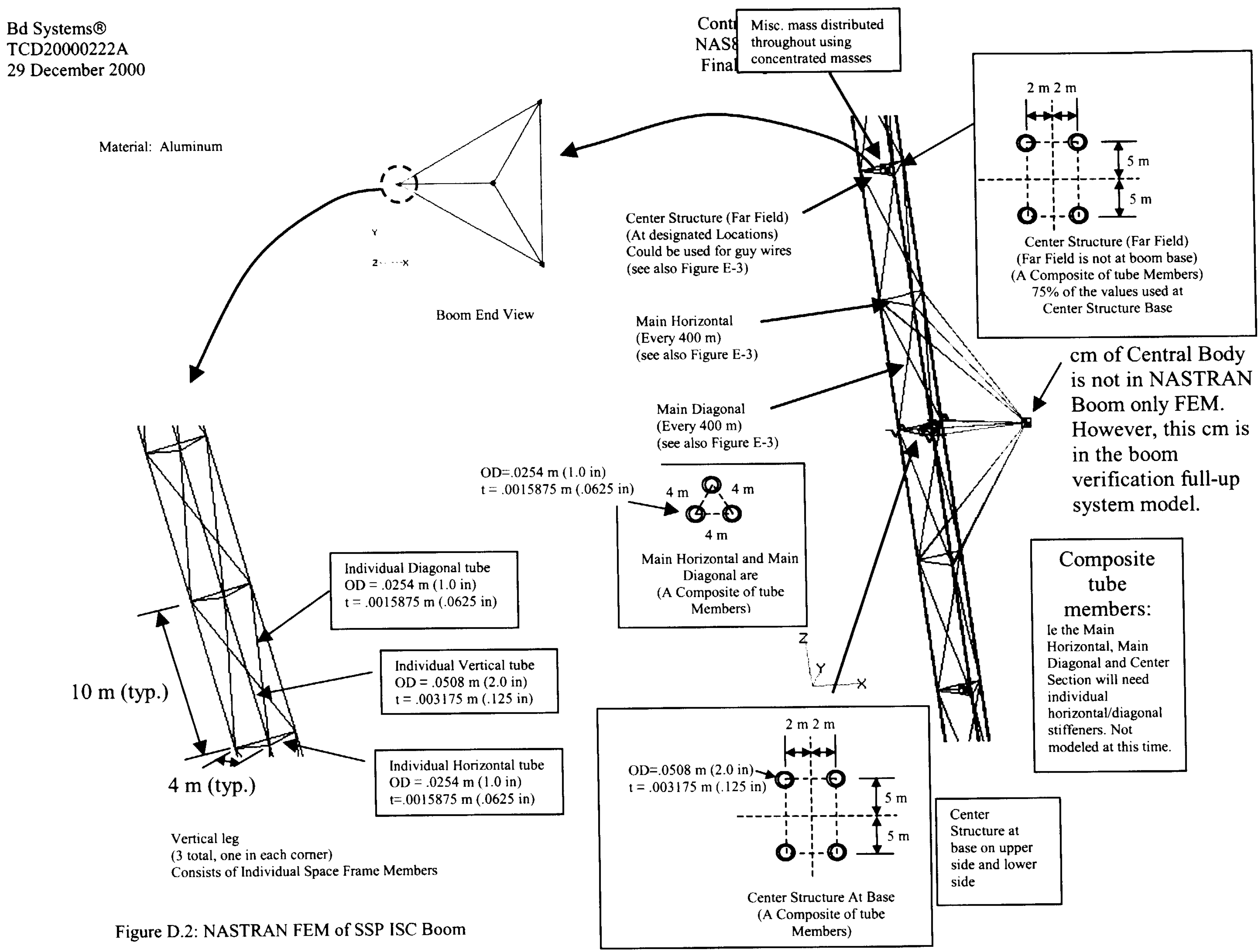


Figure D.2: NASTRAN FEM of SSP ISC Boom

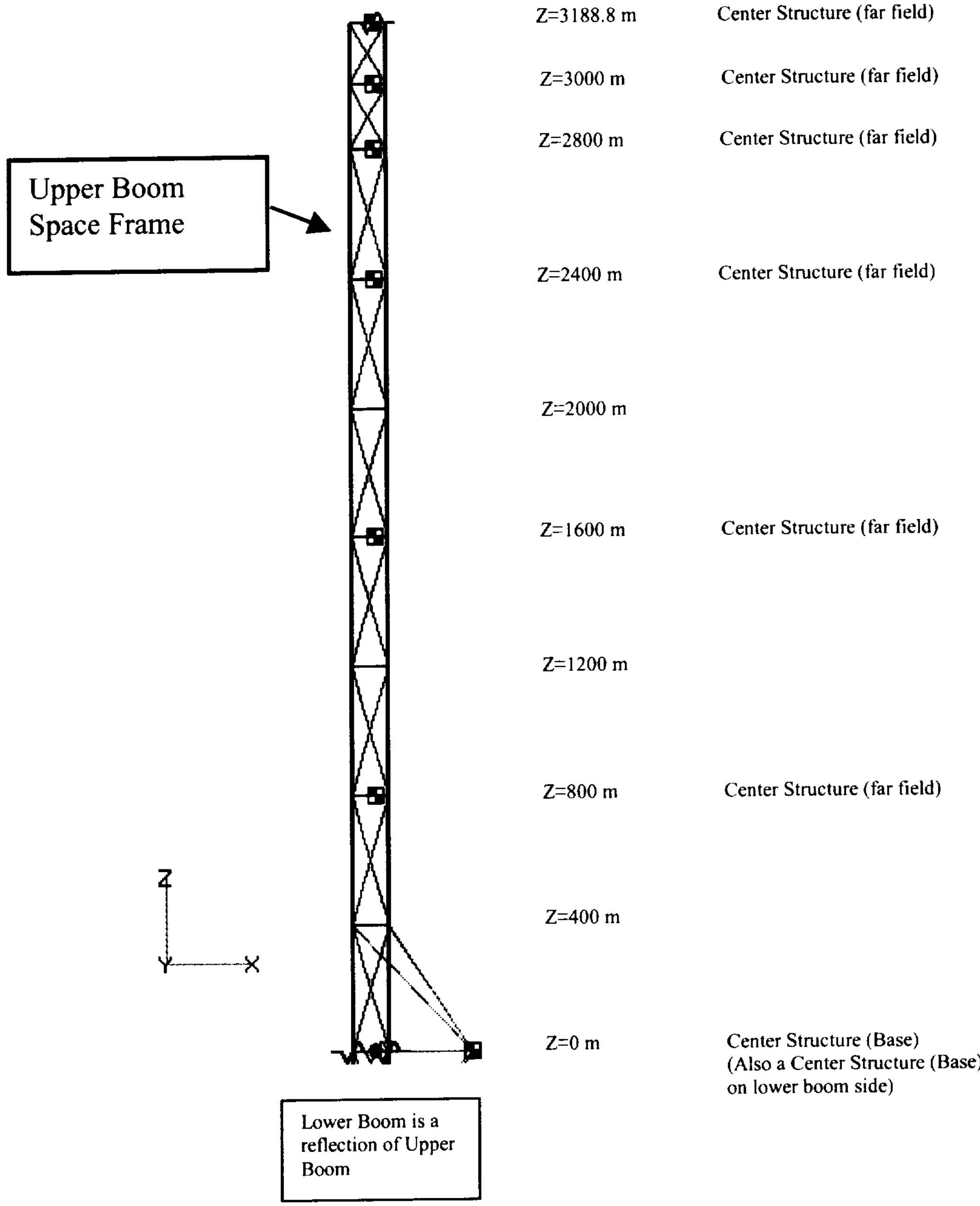


Figure D.3: Upper Boom Space Frame System: Station Designations

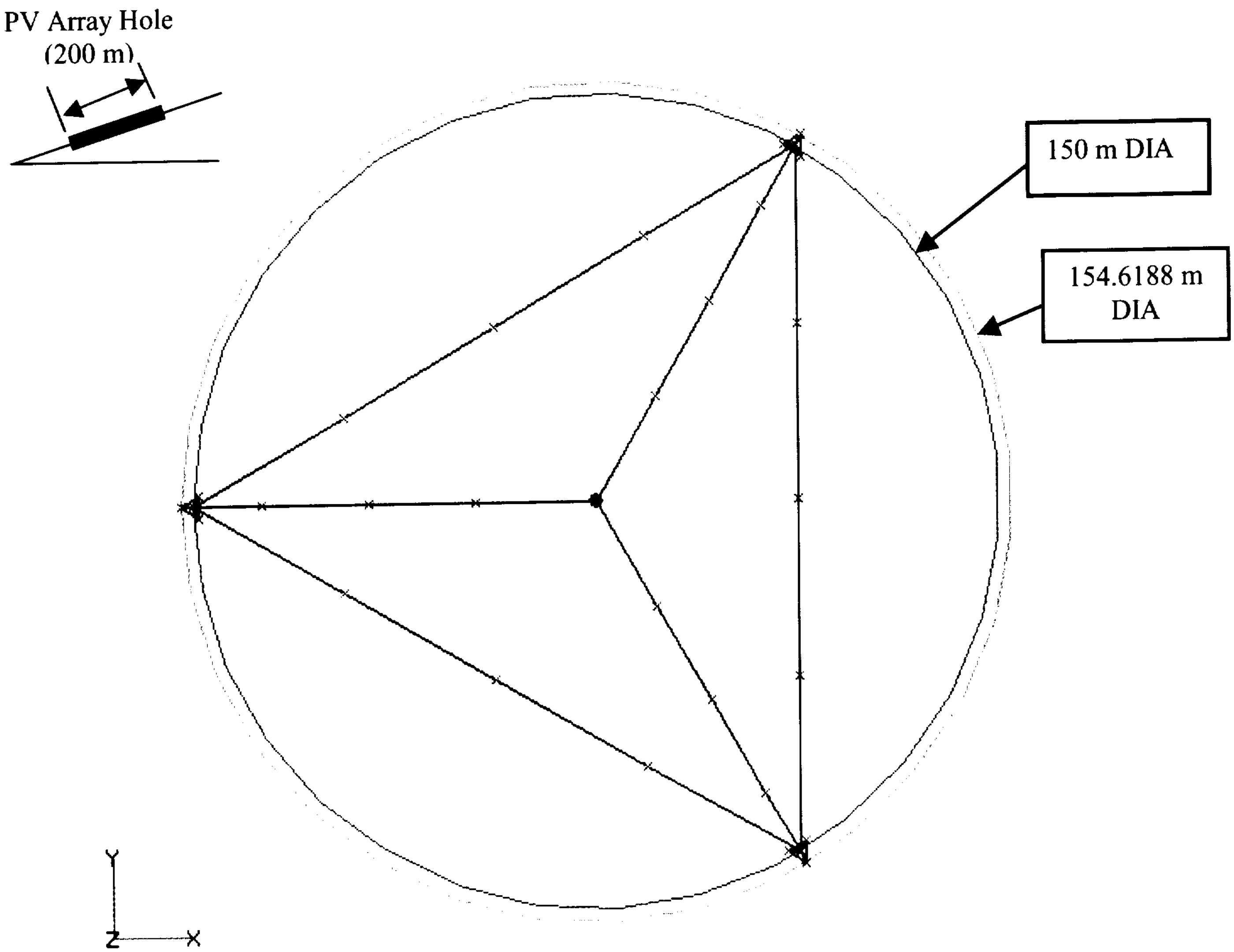


Figure D.4: Clearance Requirements of Boom:

An excerpt of ssp5_boom_top_sf.dat

```
$###############################################################################
$ ssp5_boom_top_sf.dat
$ Emmett McDonald
$ 11 Sept 2000
$
$ SSP Boom, Upper
$ Metric SI Units: Length=meters(m), mass=kg, Force=Newtons, time=seconds
$ (+x - perpendicular to z axis in direction of beam, +y - RHR, +z along boom toward
upper)
$
$ ASSUMPTION:
$   Space Frame Concept - 123456 at cbars
$   Main Vertical: EDGE  - 3 composite frame groupings, each grouping consists of
$                          of 3 individual vertical tubes and corresponding
$                          individual horizontal and diagonal tubes
$         1) Individual vertical tubes modeled as cbars
$         2) Individual horizontal tubes modeled as cbars
$         3) Individual diagonal tubes modeled as cbars
$   Main: CENTER - Connects the main vertical edge frames to a center point
$                  of boom at key stations along boom
$         1) Composite Frame (assume square frame system) modeled as cbars
$   Main: HORIZONTAL - Connects the 3 composite frame groupings at key stations
$                      along the boom
$         1) Composite Frame (assume triangular frame system) modeled as cbars
$   Main: DIAGONAL - Connects the 3 composite frame groupings at key
$                    stations along the boom
$         1) Composite Frame (assume triangular frame system) modeled as cbars
$   Interface Plates (Analytical):  Massless Interface plates that transition
$                                   loads of the individual tubes for a specific
$                                   main vertical frame grouping into a center
$                                   point for that frame grouping at key stations
$                                   along the beam.
$
$
$ ORGANIZATION:
$ ...PROPERTIES AND MATERIALS - Boom, Upper...
$ ...CENTER BARS...
$ removed...INTERFACE PLATES - ANALYTICAL...
$ ...CBARS ALONG INTERFACE PLATES - ANALYTICAL...
$ ...MAIN HORZ...
$ ...MAIN DIAG...
$ ...MAIN VERTICAL - EDGE AND CENTER...
$
$
$###############################################################################
$
$------------------------------------------------------------------------------
$  PROPERTIES AND MATERIALS - Boom, Upper
$------------------------------------------------------------------------------
$1111111222222223333333344444444555555556666666677777777888888889999999900000000
$
$ BOOM - TOP
$
$ Metric Units A=m2, IXX,IYY,J = m4
$ TUBE: OD = .0508 m (2 in), t =.003175 m (.125 in)
PBAR         101      100 4.75E-4 1.35E-7 1.35E-7 2.71E-7
$ TUBE: OD = .0254 m (1 in), t =.0015875 m (.125 in)
PBAR         102      100 1.19E-4 8.46E-9 8.46E-9 1.69E-8
$ TUBE: OD = .0254 m (1 in), t =.0015875 m (.125 in)
PBAR         103      100 1.19E-4 8.46E-9 8.46E-9 1.69E-8
$
$ CENTER STRUCTURE (AT BASE) - COMPOSITE TRUSS
$ Assume Square tube Pattern:  4 TUBES: .0508 m (2 in), t=.003175 m (.125 in)
$                              +z/-z = +5m/-5m  +/-y = +2m/-2m
$                              Assume:  A=4*indiv tube area
$                                       I=Ad^2
PBAR         111      100  1.9E-3 4.75E-2  7.6E-3 5.51E-2
$
$ CENTER STRUCTURE ("NOT" AT BASE) - COMPOSITE TRUSS (USE 75% of these values)
```

```
$ Assume Square tube Pattern:  4 TUBES: .0508 m (2 in), t=.003175 m (.125 in)
$                              +z/-z = +5m/-5m   +/-y = +2m/-2m
$                              Assume:  A=4*indiv tube area
$                                       I=Ad^2
PBAR         112     100 1.43E-3 3.56E-2  5.7E-3 4.13E-2
$
$
$
$ MAIN HORZ - COMPOSITE TRUSS
PBAR         114     100 3.56E-4  9.5E-4  9.5E-4  1.9E-3
$ MAIN DIAG - COMPOSITE TRUSS
PBAR         115     100 3.56E-4  9.5E-4  9.5E-4  1.9E-3
$
$$$$$ $ Interface plates - Analytical
$$$$$ PSHELL       180     180      .6     180              180
$$$$$ $ CBARS along interface plates (Analytical) - zero mass and .6 m DIA solid
$$$$$ PBAR         181     180   .2827 6.36E-3 6.36E-3 1.27E-2
$ CBARS along interface plates (Analytical) - zero mass and .45 m DIA solid
PBAR         181     180   .1590 2.01E-3 2.01E-3 4.03E-3
$
$
$ Metric Units: I=Kg-m2, E=N/m2, ro=kg/m3
$Aluminum E=7.10E10 N/m2 (10.3E6 lb/in2)  ro=2.71E3 kg/m3 (.098 lb/in3 = 2.538E-4 lb-
s2/in)
MAT1         100 7.10E10            .30  2.71E3
$
$Aluminum - NO DENSITY
MAT1         180 7.10E10            .30  1.0E-1
$
$
$
$ MISC (1.37E3 at 6 locations) and Connection mass (.33E3 at 6 locations)
$11111111222222223333333344444444555555556666666677777777888888889999999
CONM2     142001  108001        0  1.70E3
CONM2     142002  116001        0  1.70E3
CONM2     142003  124001        0  1.70E3
CONM2     142004  128001        0  1.70E3
CONM2     142005  130001        0  1.70E3
CONM2     142006  131901        0  1.70E3
```

An excerpt of ssp5_boom_bottom_sf.dat

```
$##############################################################################
$ ssp5_boom_bot_sf.dat
$ Emmett McDonald
$ 11 Sept 2000
$
$ SSP Boom, Bottom
$ Metric SI Units: Length=meters(m), mass=kg, Force=Newtons, time=seconds
$ (+x - perpendicular to z axis in direction of beam, +y - RHR, +z along boom toward
upper)
$
$ ASSUMPTION:
$   Space Frame Concept - 123456 at cbars
$   Main Vertical: EDGE  - 3 composite frame groupings, each grouping consists of
$                          of 3 individual vertical tubes and corresponding
$                          individual horizontal and diagonal tubes
$         1) Individual vertical tubes modeled as cbars
$         2) Individual horizontal tubes modeled as cbars
$         3) Individual diagonal tubes modeled as cbars
$   Main: CENTER - Connects the main vertical edge frames to a center point
$                  of boom at key stations along boom
$         1) Composite Frame (assume square frame system) modeled as cbars
$   Main: HORIZONTAL - Connects the 3 composite frame groupings at key stations
$                      along the boom
$         1) Composite Frame (assume triangular frame system) modeled as cbars
$   Main: DIAGONAL - Connects the 3 composite frame groupings at key
$                             stations along the boom
$         1) Composite Frame (assume triangular frame system) modeled as cbars
$   Interface Plates (Analytical):  Massless Interface plates that transition
$                                   loads of the individual tubes for a specific
$                                   main vertical frame grouping into a center
$                                   point for that frame grouping at key stations
$                                   along the beam.
$
$ ORGANIZATION:
$ ...PROPERTIES AND MATERIALS - Boom, Bottom...
$ ...CENTER BARS...
$ removed...INTERFACE PLATES - ANALYTICAL...
$ ...CBARS ALONG INTERFACE PLATES - ANALYTICAL...
$ ...MAIN HORZ...
$ ...MAIN DIAG...
$ ...MAIN VERTICAL - EDGE AND CENTER...
$
$
$##############################################################################
$
$-----------------------------------------------------------------------------
$  ...PROPERTIES AND MATERIALS - Boom, Bottom...
$-----------------------------------------------------------------------------
$111111122222222333333334444444455555555666666667777777788888888999999990000000
$
$ BOOM - BOTTOM
$
$ Metric Units A=m2, IXX,IYY,J = m4
$ TUBE: OD = .0508 m (2 in), t =.003175 m (.125 in)
PBAR         201     200 4.75E-4 1.35E-7 1.35E-7 2.71E-7
$ TUBE: OD = .0254 m (1 in), t =.0015875 m (.125 in)
PBAR         202     200 1.19E-4 8.46E-9 8.46E-9 1.69E-8
$ TUBE: OD = .0254 m (1 in), t =.0015875 m (.125 in)
PBAR         203     200 1.19E-4 8.46E-9 8.46E-9 1.69E-8
$
$ CENTER STRUCTURE (AT BASE) - COMPOSITE TRUSS
$ Assume Square tube Pattern:  4 TUBES: .0508 m (2 in), t=.003175 m (.125 in)
$                              +z/-z = +5m/-5m  +/-y = +2m/-2m
$                              Assume:  A=4*indiv tube area
$                                         I=Ad^2
PBAR         211     200  1.9E-3 4.75E-2  7.6E-3 5.51E-2
$
$ CENTER STRUCTURE ("NOT" AT BASE) - COMPOSITE TRUSS (USE 75% of these values)
$ Assume Square tube Pattern:  4 TUBES: .0508 m (2 in), t=.003175 m (.125 in)
```

```
$                                       +z/-z = +5m/-5m  +/-y = +2m/-2m
$                                       Assume:  A=4*indiv tube area
$                                                I=Ad^2
PBAR          212     200 1.43E-3 3.56E-2  5.7E-3 4.13E-2
$
$
$
$ MAIN HORZ - COMPOSITE TRUSS
PBAR          214     200 3.56E-4  9.5E-4  9.5E-4  1.9E-3
$ MAIN DIAG - COMPOSITE TRUSS
PBAR          215     200 3.56E-4  9.5E-4  9.5E-4  1.9E-3
$
$$$$$ $ Interface plates - Analytical
$$$$$ PSHELL      280     280     .6     280             280
$$$$$ $ CBARS along interface plates (Analytical) - zero mass and .6 m DIA solid
$$$$$ PBAR        281     280   .2827 6.36E-3 6.36E-3 1.27E-2
$$$$$ $ CBARS along interface plates (Analytical) - zero mass and .45 m DIA solid
PBAR          281     280   .1590 2.01E-3 2.01E-3 4.03E-3
$
$
$ Metric Units: I=Kg-m2, E=N/m2, ro=kg/m3
$Aluminum E=7.10E10 N/m2 (10.3E6 lb/in2)  ro=2.71E3 kg/m3 (.098 lb/in3 = 2.538E-4 lb-
s2/in)
MAT1          200 7.10E10             .30   2.71E3
$
$Aluminum - NO DENSITY
MAT1          280 7.10E10             .30   1.0E-1
$
$
$
$ MISC (1.37E3 at 6 locations) and Connection mass (.33E3 at 6 locations)
$111111112222222233333333444444445555555566666666777777778888888899999999
CONM2     242001  208001        0  1.70E3
CONM2     242002  216001        0  1.70E3
CONM2     242003  224001        0  1.70E3
CONM2     242004  228001        0  1.70E3
CONM2     242005  230001        0  1.70E3
CONM2     242006  231901        0  1.70E3
$
```

Excerpt of ssp5_boom_sf_ng_13loc_dy_aset.f06, E. McDonald, 23 Oct 2000 (BOOM ONLY)

```
1 SSP5_BOOM_SF_NG_13LOC_DY_ASET.DAT                     OCT. 18, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE     12
  NORMAL MODES ANALYSIS                                           MATRIX PROCESSING FOR SUPERELEMENT        0 (RESIDUAL )
0
                       O U T P U T   F R O M   G R I D   P O I N T   W E I G H T   G E N E R A T O R
0                                                 REFERENCE POINT =        0

                                 MO - RIGID BODY MASS MATRIX IN BASIC COORDINATE SYSTEM
                     ***                                                                                  ***
                     *  1.616863E+05 -8.488657E-13  0.000000E+00 -5.169879E-26 -2.529123E-08 -3.544972E-05 *
                     * -1.139673E-12  1.616863E+05  0.000000E+00  3.997411E-08  0.000000E+00 -1.439671E-01 *
                     *  0.000000E+00  0.000000E+00  1.616863E+05  3.545100E-05  1.439671E-01  0.000000E+00 *
                     *  0.000000E+00 -2.318702E-07  3.545109E-05  6.285218E+11 -4.041448E-03  4.491835E-09 *
                     *  1.975422E-07  2.584939E-26  1.439671E-01 -4.042393E-03  6.285218E+11 -2.723725E-09 *
                     * -3.544975E-05 -1.439671E-01 -2.019484E-28 -2.793968E-09  6.984919E-10  6.705735E+08 *
                     ***                                                                                  ***
                                   S - TRANSFORMATION MATRIX FOR SCALAR MASS PARTITION
                                  ***                                          ***
                                  *  1.000000E+00  0.000000E+00  0.000000E+00 *
                                  *  0.000000E+00  1.000000E+00  0.000000E+00 *
                                  *  0.000000E+00  0.000000E+00  1.000000E+00 *
                                  ***                                          ***
              DIRECTION
         MASS AXIS SYSTEM (S)     MASS              X-C.G.        Y-C.G.        Z-C.G.
                  X             1.616863E+05     -3.197474E-31  2.192500E-10 -1.564216E-13
                  Y             1.616863E+05     -8.904096E-07  0.000000E+00 -2.472325E-13
                  Z             1.616863E+05     -8.904096E-07  2.192579E-10  0.000000E+00
0                                     I(S) - INERTIAS RELATIVE TO C.G.
                                  ***                                          ***
                                  *  6.285218E+11  4.041448E-03 -4.491870E-09 *
                                  *  4.041448E-03  6.285218E+11  2.723725E-09 *
                                  * -4.491870E-09  2.723725E-09  6.705735E+08 *
                                  ***                                          ***
                                             I(Q) - PRINCIPAL INERTIAS
                                  ***                                          ***
                                  *  6.285218E+11                              *
                                  *                6.285218E+11                *
                                  *                              6.705735E+08 *
                                  ***                                          ***
                                             Q - TRANSFORMATION MATRIX
                                               I(Q) = QT*IBAR(S)*Q
                                  ***                                          ***
                                  *  1.000000E+00  0.000000E+00  0.000000E+00 *
                                  *  0.000000E+00  1.000000E+00  0.000000E+00 *
                                  *  0.000000E+00  0.000000E+00  1.000000E+00 *
                                  ***                                          ***
```

1 SSP5_BOOM_SF_NG_13LOC_DY_ASET.DAT OCT. 18, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 1860
NORMAL MODES ANALYSIS SUPERELEMENT SOLUTION
0

R E A L   E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIAN FREQUENCY	CYCLIC FREQUENCY	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	-1.633329E-07	4.041447E-04	6.432163E-05	1.000000E+00	-1.633329E-07
2	2	-1.309557E-07	3.618780E-04	5.759467E-05	1.000000E+00	-1.309557E-07
3	3	-7.068505E-09	8.407440E-05	1.338086E-05	1.000000E+00	-7.068505E-09
4	4	-5.122070E-09	7.156864E-05	1.139050E-05	1.000000E+00	-5.122070E-09
5	5	1.088080E-08	1.043111E-04	1.660163E-05	1.000000E+00	1.088080E-08
6	6	6.154570E-08	2.480840E-04	3.948380E-05	1.000000E+00	6.154570E-08
7	7	9.759462E-03	9.878999E-02	1.572291E-02	1.000000E+00	9.759462E-03
8	8	9.759543E-03	9.879040E-02	1.572298E-02	1.000000E+00	9.759543E-03
9	9	2.034302E-02	1.426290E-01	2.270010E-02	1.000000E+00	2.034302E-02
10	10	6.646413E-02	2.578064E-01	4.103116E-02	1.000000E+00	6.646413E-02
11	11	6.646430E-02	2.578067E-01	4.103121E-02	1.000000E+00	6.646430E-02
12	12	8.589462E-02	2.930779E-01	4.664478E-02	1.000000E+00	8.589462E-02
13	13	2.134917E-01	4.620516E-01	7.353780E-02	1.000000E+00	2.134917E-01
14	14	2.134918E-01	4.620517E-01	7.353780E-02	1.000000E+00	2.134918E-01
15	15	2.951329E-01	5.432613E-01	8.646273E-02	1.000000E+00	2.951329E-01
16	16	4.354359E-01	6.598757E-01	1.050225E-01	1.000000E+00	4.354359E-01
17	17	6.812542E-01	8.253813E-01	1.313635E-01	1.000000E+00	6.812542E-01
18	18	6.812558E-01	8.253822E-01	1.313636E-01	1.000000E+00	6.812558E-01
19	19	4.527360E+00	2.127759E+00	3.386434E-01	1.000000E+00	4.527360E+00
20	20	5.820129E+00	2.412494E+00	3.839604E-01	1.000000E+00	5.820129E+00
21	21	9.491925E+00	3.080897E+00	4.903399E-01	1.000000E+00	9.491925E+00
22	22	1.282148E+01	3.580710E+00	5.698877E-01	1.000000E+00	1.282148E+01
23	23	1.282150E+01	3.580712E+00	5.698880E-01	1.000000E+00	1.282150E+01
24	24	1.382777E+01	3.718571E+00	5.918289E-01	1.000000E+00	1.382777E+01
25	25	1.382779E+01	3.718573E+00	5.918293E-01	1.000000E+00	1.382779E+01
26	26	1.673878E+01	4.091305E+00	6.511514E-01	1.000000E+00	1.673878E+01
27	27	3.403545E+01	5.833991E+00	9.285085E-01	1.000000E+00	3.403545E+01
28	28	3.403549E+01	5.833994E+00	9.285091E-01	1.000000E+00	3.403549E+01
29	29	3.428328E+01	5.855193E+00	9.318828E-01	1.000000E+00	3.428328E+01
30	30	3.428331E+01	5.855196E+00	9.318833E-01	1.000000E+00	3.428331E+01

0

ssp5_boom_sf_ng_13loc_st.f06 (Static Loads on Upper End of Upper Boom. Upper Boom Base Fixed) (An Excerpt)

```
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                              NOV. 21, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    478
  STATIC ANALYSIS                                                   DATA RECOVERY FOR SUPERELEMENT         0 (RESIDUAL )
0     LOAD FX = 20 N AT BOOM, UPPER END (TOP)                                                        SUBCASE 1001

                                       D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      2.517928E-01   1.002802E-08   2.008612E-10   6.106400E-06   1.098348E-04  -5.412926E-11
       231901      G     -2.704772E-02   1.037041E-09  -1.256144E-11  -2.906610E-07   1.052416E-05   1.819996E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                              NOV. 21, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    479
  STATIC ANALYSIS                                                   DATA RECOVERY FOR SUPERELEMENT         0 (RESIDUAL )
0     LOAD FY = 20 N AT BOOM, UPPER END (TOP)                                                        SUBCASE 1002

                                       D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      1.002802E-08   2.517929E-01  -1.257524E-10  -1.098349E-04   6.106408E-06   2.695994E-11
       231901      G      1.038834E-09  -2.704778E-02   9.964591E-12  -1.052418E-05  -2.906613E-07  -2.143183E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                              NOV. 21, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    480
  STATIC ANALYSIS                                                   DATA RECOVERY FOR SUPERELEMENT         0 (RESIDUAL )
0     LOAD FZ = 20 N AT BOOM, UPPER END (TOP) (BOOM AXIAL LOADING)                                   SUBCASE 1003

                                       D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      2.008612E-10  -1.257524E-10   4.886293E-04   2.960159E-14   7.269726E-13  -1.299740E-05
       231901      G      1.295385E-11  -1.367107E-11  -6.568940E-06  -4.560693E-15  -4.104938E-15   1.814090E-08
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                              NOV. 21, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    481
  STATIC ANALYSIS                                                   DATA RECOVERY FOR SUPERELEMENT         0 (RESIDUAL )
0     LOAD MX =  10000 N-M AT BOOM, UPPER END (TOP)                                                  SUBCASE 1004

                                       D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      3.053200E-03  -5.491742E-02   1.480079E-11   9.498738E-05  -5.126904E-13  -1.491296E-11
       231901      G      1.453305E-04   5.262089E-03  -1.736071E-12   2.000275E-06  -2.073411E-15   4.012494E-12
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                              NOV. 21, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    482
  STATIC ANALYSIS                                                   DATA RECOVERY FOR SUPERELEMENT         0 (RESIDUAL )
0     LOAD MY =  10000 N-M AT BOOM, UPPER END (TOP)                                                  SUBCASE 1005

                                       D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      5.491740E-02   3.053204E-03   3.634863E-10  -5.126902E-13   9.498736E-05   1.255651E-11
```

```
      231901      G      -5.262078E-03   1.453307E-04  -2.130299E-12   4.086835E-16   2.000271E-06   2.984677E-12
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                                        NOV. 21, 19 0  CSA/NASTRAN   IBM PC      07/21/99  PAGE    483
  STATIC ANALYSIS                                                               DATA RECOVERY FOR SUPERELEMENT        0 (RESIDUAL )



0      LOAD MZ =  10000 N-M AT BOOM, UPPER END (TOP)                                                             SUBCASE 1006

                                             D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      -2.706463E-08   1.347998E-08  -6.498701E-03  -1.491296E-11   1.255651E-11   3.563758E-03
       231901      G       8.488112E-09  -9.099953E-09  -9.070437E-06  -3.539443E-12  -2.891001E-12  -1.540669E-04
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                                        NOV. 21, 19 0  CSA/NASTRAN   IBM PC      07/21/99  PAGE    484
  STATIC ANALYSIS                                                               DATA RECOVERY FOR SUPERELEMENT        0 (RESIDUAL )
0      LOAD FX = 20 N AT BOOM, LOWER END (BOT)                                                                   SUBCASE 2001

                                             D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      -2.704772E-02   1.038834E-09   1.295384E-11   2.906610E-07  -1.052416E-05   1.697622E-11
       231901      G       2.517928E-01   9.916226E-09  -1.977961E-10  -6.106400E-06  -1.098348E-04  -5.219564E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                                        NOV. 21, 19 0  CSA/NASTRAN   IBM PC      07/21/99  PAGE    485
  STATIC ANALYSIS                                                               DATA RECOVERY FOR SUPERELEMENT        0 (RESIDUAL )
0      LOAD FY = 20 N AT BOOM, LOWER END (BOT)                                                                   SUBCASE 2002

                                             D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G       1.037040E-09  -2.704778E-02  -1.367106E-11   1.052418E-05   2.906613E-07  -1.819990E-11
       231901      G       9.916227E-09   2.517929E-01   1.246758E-10   1.098349E-04  -6.106408E-06   2.525499E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                                        NOV. 21, 19 0  CSA/NASTRAN   IBM PC      07/21/99  PAGE    486
  STATIC ANALYSIS                                                               DATA RECOVERY FOR SUPERELEMENT        0 (RESIDUAL )
0      LOAD FZ = 20 N AT BOOM, LOWER END (BOT) (BOOM AXIAL LOADING)                                              SUBCASE 2003

                                             D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      -1.256144E-11   9.964584E-12  -6.568940E-06  -3.472140E-15  -4.260599E-15  -1.814087E-08
       231901      G      -1.977961E-10   1.246758E-10   4.886293E-04   2.969441E-14   7.259546E-13   1.299740E-05
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                                        NOV. 21, 19 0  CSA/NASTRAN   IBM PC      07/21/99  PAGE    487
  STATIC ANALYSIS                                                               DATA RECOVERY FOR SUPERELEMENT        0 (RESIDUAL )
0      LOAD MX =  10000 N-M AT BOOM, LOWER END (BOT)                                                             SUBCASE 2004

                                             D I S P L A C E M E N T   V E C T O R
```

```
     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G     -1.453305E-04  -5.262089E-03  -2.280347E-12   2.000275E-06   4.087172E-16  -3.539443E-12
       231901      G     -3.053200E-03   5.491742E-02   1.484721E-11   9.498738E-05  -5.096353E-13   1.477201E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                                        NOV. 21, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    488
  STATIC ANALYSIS                                                             DATA RECOVERY FOR SUPERELEMENT        0 (RESIDUAL )
0     LOAD MY =  10000 N-M AT BOOM, LOWER END (BOT)                                                            SUBCASE 2005

                                         D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      5.262078E-03  -1.453307E-04  -2.052467E-12  -2.073404E-15   2.000271E-06  -2.891000E-12
       231901      G     -5.491740E-02  -3.053204E-03   3.629773E-10  -5.096353E-13   9.498736E-05  -1.282914E-11
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                                        NOV. 21, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    489
  STATIC ANALYSIS                                                             DATA RECOVERY FOR SUPERELEMENT        0 (RESIDUAL )
0     LOAD MZ =  10000 N-M AT BOOM, LOWER END (BOT)                                                            SUBCASE 2006

                                         D I S P L A C E M E N T   V E C T O R

     POINT ID.   TYPE          T1             T2             T3             R1             R2             R3
       131901      G      9.099987E-09  -1.071592E-08   9.070449E-06   4.012496E-12   2.984678E-12  -1.540669E-04
       231901      G     -2.609783E-08   1.262750E-08   6.498701E-03   1.477201E-11  -1.282913E-11   3.563758E-03
1 SSP5_BOOM_SF_NG_13LOC_ST.DAT                                        NOV. 21, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    490
  STATIC ANALYSIS                                                             DATA RECOVERY FOR SUPERELEMENT        0 (RESIDUAL )
0     LOAD FX = 20 N AT BOOM, UPPER END (TOP)                                                                  SUBCASE 1001
```

Verification Analysis:
Full-Up System Verification K123 (Clamshell Rotations Free - Roll, Pitch, Yaw)   An Excerpt

```
1 SSP5_MAIN_SF_NG_CLAM_K123_DY_MOD2.DAT                   NOV. 17, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE     10
  NORMAL MODES ANALYSIS                                          MATRIX PROCESSING FOR SUPERELEMENT        0 (RESIDUAL )
0

                    O U T P U T   F R O M   G R I D   P O I N T   W E I G H T   G E N E R A T O R
0                                          REFERENCE POINT =       0

                     MO - RIGID BODY MASS MATRIX IN BASIC COORDINATE SYSTEM
 ***                                                                                         ***
 *  1.692119E+07 -8.488657E-13  0.000000E+00 -5.169879E-26 -2.529123E-08 -3.544972E-05 *
 * -1.139673E-12  1.692119E+07  0.000000E+00  2.025105E+02  0.000000E+00  3.778649E+09 *
 *  0.000000E+00  0.000000E+00  1.692119E+07  3.545100E-05 -3.778649E+09  0.000000E+00 *
 *  0.000000E+00  2.025104E+02  3.545109E-05  4.650430E+13 -4.041448E-03  4.491835E-09 *
 *  1.975422E-07  2.584939E-26 -3.778649E+09 -4.042393E-03  5.003726E+13 -1.139207E+05 *
 * -3.544975E-05  3.778649E+09 -2.019484E-28 -2.793968E-09 -1.139207E+05  7.609928E+12 *
 ***                                                                                         ***
                       S - TRANSFORMATION MATRIX FOR SCALAR MASS PARTITION
                       ***                                         ***
                       *  1.000000E+00  0.000000E+00  0.000000E+00 *
                       *  0.000000E+00  1.000000E+00  0.000000E+00 *
                       *  0.000000E+00  0.000000E+00  1.000000E+00 *
                       ***                                         ***
              DIRECTION
         MASS AXIS SYSTEM (S)     MASS              X-C.G.        Y-C.G.        Z-C.G.
                    X          1.692119E+07     -3.055270E-33  2.094990E-12 -1.494649E-15
                    Y          1.692119E+07      2.233087E+02  0.000000E+00 -1.196786E-05
                    Z          1.692119E+07      2.233087E+02  2.095066E-12  0.000000E+00
0                                I(S) - INERTIAS RELATIVE TO C.G.
                       ***                                         ***
                       *  4.650430E+13 -3.875071E-03  4.522235E+04 *
                       * -3.875071E-03  4.919346E+13  1.139207E+05 *
                       *  4.522235E+04  1.139207E+05  6.766123E+12 *
                       ***                                         ***
                                     I(Q) - PRINCIPAL INERTIAS
                       ***                                         ***
                       *  4.650430E+13                             *
                       *                4.919346E+13               *
                       *                              6.766123E+12 *
                       ***                                         ***
                                     Q - TRANSFORMATION MATRIX
                                        I(Q) = QT*IBAR(S)*Q
                       ***                                         ***
                       *  1.000000E+00  0.000000E+00  0.000000E+00 *
                       *  0.000000E+00  1.000000E+00  0.000000E+00 *
                       *  0.000000E+00  0.000000E+00  1.000000E+00 *
                       ***                                         ***
```

1 SSP5_MAIN_SF_NG_CLAM_K123_DY_MOD2.DAT NOV. 17, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 470
NORMAL MODES ANALYSIS SUPERELEMENT SOLUTION
0

R E A L   E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIAN FREQUENCY	CYCLIC FREQUENCY	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	-6.227084E-10	2.495413E-05	3.971572E-06	1.000000E+00	-6.227084E-10
2	2	-3.684854E-10	1.919597E-05	3.055134E-06	1.000000E+00	-3.684854E-10
3	3	-3.099192E-10	1.760452E-05	2.801847E-06	1.000000E+00	-3.099192E-10
4	4	-1.515650E-10	1.231117E-05	1.959384E-06	1.000000E+00	-1.515650E-10
5	5	2.941186E-16	1.714989E-08	2.729489E-09	1.000000E+00	2.941186E-16
6	6	2.941322E-16	1.715028E-08	2.729552E-09	1.000000E+00	2.941322E-16
7	7	5.881085E-16	2.425095E-08	3.859658E-09	1.000000E+00	5.881085E-16
8	8	5.882390E-16	2.425364E-08	3.860086E-09	1.000000E+00	5.882390E-16
9	9	5.882525E-16	2.425392E-08	3.860131E-09	1.000000E+00	5.882525E-16
10	10	5.882712E-16	2.425430E-08	3.860192E-09	1.000000E+00	5.882712E-16
11	11	2.397129E-11	4.896048E-06	7.792303E-07	1.000000E+00	2.397129E-11
12	12	2.314021E-10	1.521191E-05	2.421050E-06	1.000000E+00	2.314021E-10
13	13	5.709955E-05	7.556424E-03	1.202642E-03	1.000000E+00	5.709955E-05
14	14	6.849127E-05	8.275946E-03	1.317158E-03	1.000000E+00	6.849127E-05
15	15	8.134064E-04	2.852028E-02	4.539143E-03	1.000000E+00	8.134064E-04
16	16	1.695564E-03	4.117722E-02	6.553559E-03	1.000000E+00	1.695564E-03
17	17	1.704217E-02	1.305457E-01	2.077699E-02	1.000000E+00	1.704217E-02
18	18	1.785241E-02	1.336129E-01	2.126515E-02	1.000000E+00	1.785241E-02
19	19	2.669046E-02	1.633721E-01	2.600148E-02	1.000000E+00	2.669046E-02
20	20	3.430796E-02	1.852241E-01	2.947933E-02	1.000000E+00	3.430796E-02
21	21	6.357310E-02	2.521371E-01	4.012886E-02	1.000000E+00	6.357310E-02
22	22	6.372374E-02	2.524356E-01	4.017637E-02	1.000000E+00	6.372374E-02
23	23	6.733700E-02	2.594937E-01	4.129971E-02	1.000000E+00	6.733700E-02
24	24	6.794554E-02	2.606637E-01	4.148591E-02	1.000000E+00	6.794554E-02
25	25	1.575687E-01	3.969493E-01	6.317644E-02	1.000000E+00	1.575687E-01

Verification Analysis:
Full-Up System Verification K123456 (Clamshell Rotations Fixed to Boom)   An Excerpt

```
1 SSP5_MAIN_SF_NG_CLAM_K123_DY_MOD2.DAT                        NOV. 17, 19 0  CSA/NASTRAN   IBM PC     07/21/99  PAGE    10
  NORMAL MODES ANALYSIS                                              MATRIX PROCESSING FOR SUPERELEMENT          0 (RESIDUAL )
0

                     O U T P U T   F R O M   G R I D   P O I N T   W E I G H T   G E N E R A T O R
0                                        REFERENCE POINT =        0

                          MO - RIGID BODY MASS MATRIX IN BASIC COORDINATE SYSTEM
                ***                                                                              ***
                *  1.692119E+07 -8.488657E-13  0.000000E+00 -5.169879E-26 -2.529123E-08 -3.544972E-05 *
                * -1.139673E-12  1.692119E+07  0.000000E+00  2.025105E+02  0.000000E+00  3.778649E+09 *
                *  0.000000E+00  0.000000E+00  1.692119E+07  3.545100E-05 -3.778649E+09  0.000000E+00 *
                *  0.000000E+00  2.025104E+02  3.545109E-05  4.650430E+13 -4.041448E-03  4.491835E-09 *
                *  1.975422E-07  2.584939E-26 -3.778649E+09 -4.042393E-03  5.003726E+13 -1.139207E+05 *
                * -3.544975E-05  3.778649E+09 -2.019484E-28 -2.793968E-09 -1.139207E+05  7.609928E+12 *
                ***                                                                              ***
                             S - TRANSFORMATION MATRIX FOR SCALAR MASS PARTITION
                           ***                                        ***
                           *  1.000000E+00  0.000000E+00  0.000000E+00 *
                           *  0.000000E+00  1.000000E+00  0.000000E+00 *
                           *  0.000000E+00  0.000000E+00  1.000000E+00 *
                           ***                                        ***
                 DIRECTION
            MASS AXIS SYSTEM (S)     MASS             X-C.G.        Y-C.G.        Z-C.G.
                     X            1.692119E+07     -3.055270E-33  2.094990E-12 -1.494649E-15
                     Y            1.692119E+07      2.233087E+02  0.000000E+00 -1.196786E-05
                     Z            1.692119E+07      2.233087E+02  2.095066E-12  0.000000E+00
0                                   I(S) - INERTIAS RELATIVE TO C.G.
                           ***                                        ***
                           *  4.650430E+13 -3.875071E-03  4.522235E+04 *
                           * -3.875071E-03  4.919346E+13  1.139207E+05 *
                           *  4.522235E+04  1.139207E+05  6.766123E+12 *
                           ***                                        ***
                                       I(Q) - PRINCIPAL INERTIAS
                           ***                                        ***
                           *  4.650430E+13                             *
                           *                4.919346E+13               *
                           *                              6.766123E+12 *
                           ***                                        ***
                                       Q - TRANSFORMATION MATRIX
                                          I(Q) = QT*IBAR(S)*Q
                           ***                                        ***
                           *  1.000000E+00  0.000000E+00  0.000000E+00 *
                           *  0.000000E+00  1.000000E+00  0.000000E+00 *
                           *  0.000000E+00  0.000000E+00  1.000000E+00 *
                           ***                                        ***
```

1 SSP5_MAIN_SF_NG_CLAM_K123_DY_MOD2.DAT   NOV. 17, 19 0 CSA/NASTRAN IBM PC 07/21/99 PAGE 470
NORMAL MODES ANALYSIS   SUPERELEMENT SOLUTION
0

R E A L   E I G E N V A L U E S

MODE NO.	EXTRACTION ORDER	EIGENVALUE	RADIAN FREQUENCY	CYCLIC FREQUENCY	GENERALIZED MASS	GENERALIZED STIFFNESS
1	1	-6.211539E-10	2.492296E-05	3.966612E-06	1.000000E+00	-6.211539E-10
2	2	-3.403050E-10	1.844736E-05	2.935988E-06	1.000000E+00	-3.403050E-10
3	3	-1.573186E-10	1.254267E-05	1.996228E-06	1.000000E+00	-1.573186E-10
4	4	-1.267169E-10	1.125686E-05	1.791585E-06	1.000000E+00	-1.267169E-10
5	5	2.600097E-11	5.099114E-06	8.115493E-07	1.000000E+00	2.600097E-11
6	6	2.316232E-10	1.521917E-05	2.422207E-06	1.000000E+00	2.316232E-10
7	7	1.076385E-06	1.037490E-03	1.651216E-04	1.000000E+00	1.076385E-06
8	8	4.630290E-06	2.151811E-03	3.424713E-04	1.000000E+00	4.630290E-06
9	9	3.412004E-05	5.841236E-03	9.296615E-04	1.000000E+00	3.412004E-05
10	10	4.456027E-05	6.675348E-03	1.062415E-03	1.000000E+00	4.456027E-05
11	11	6.563131E-05	8.101315E-03	1.289364E-03	1.000000E+00	6.563131E-05
12	12	8.650443E-05	9.300776E-03	1.480264E-03	1.000000E+00	8.650443E-05
13	13	1.034806E-04	1.017254E-02	1.619010E-03	1.000000E+00	1.034806E-04
14	14	1.287677E-04	1.134759E-02	1.806024E-03	1.000000E+00	1.287677E-04
15	15	8.450979E-04	2.907057E-02	4.626724E-03	1.000000E+00	8.450979E-04
16	16	1.754916E-03	4.189172E-02	6.667274E-03	1.000000E+00	1.754916E-03
17	17	2.071103E-02	1.439133E-01	2.290451E-02	1.000000E+00	2.071103E-02
18	18	3.299847E-02	1.816548E-01	2.891126E-02	1.000000E+00	3.299847E-02
19	19	6.701340E-02	2.588695E-01	4.120035E-02	1.000000E+00	6.701340E-02
20	20	6.716394E-02	2.591601E-01	4.124660E-02	1.000000E+00	6.716394E-02
21	21	7.099716E-02	2.664529E-01	4.240730E-02	1.000000E+00	7.099716E-02
22	22	7.160546E-02	2.675920E-01	4.258858E-02	1.000000E+00	7.160546E-02
23	23	7.839783E-02	2.799961E-01	4.456276E-02	1.000000E+00	7.839783E-02
24	24	9.186188E-02	3.030873E-01	4.823783E-02	1.000000E+00	9.186188E-02
25	25	2.565429E-01	5.065007E-01	8.061208E-02	1.000000E+00	2.565429E-01

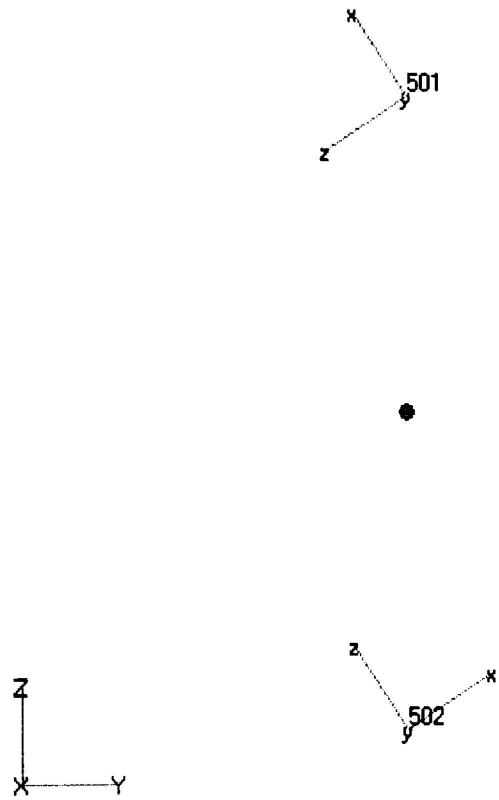


Figure D.5: Orientation of Upper and Lower Clamshells in NASTRAN Verification Runs:

Bd Systems®
TCD20000222A
29 December 2000

Contract No.
NAS8-00151
Final Report

Contract No: NAS8-00151

NASA Report Documentation Page

1. Report No. Final Report	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Space Solar Power Multi-Body Dynamics and Controls, Concepts for the Integrated Symmetrical Concentrator Configuration		5. Report Date December 29, 2000
		6. Performing Organization Code
7. Author(s) John R. Glaese, Emmett j. McDonald		8. Performing Organization Report No. TCD20000222A
9. Performing Organization Name and Address Control Dynamics, A Division of bd Systems, Inc. 600 Boulevard South, Suite 304 Huntsville, Alabama 35802		10. Work Unit No.
		11. Contract or Grant No. NAS8-00151
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812		13. Type of Report and Period Covered Final Report June 2000 – December 2000
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract:

Orbiting space solar power systems are currently being investigated for possible flight in the time frame of 2015-2020 and later. Such space solar power (SSP) satellites are required to be extremely large in order to make practical the process of collection, conversion to microwave radiation, and reconversion to electrical power at earth stations or at remote locations in space. These large structures are expected to be very flexible presenting unique problems associated with their dynamics and control. The purpose of this project is to apply the expanded TREETOPS multi-body dynamics analysis computer simulation program (with expanded capabilities developed in the previous activity) to investigate the control problems associated with the integrated symmetrical concentrator (ISC) conceptual SSP system. SSP satellites are, as noted, large orbital systems having many bodies (perhaps hundreds) with flexible arrays operating in an orbiting environment where the non-uniform gravitational forces may be the major load producers on the structure so that a high fidelity gravity model is required. The current activity arises from our NRA8-23 SERT proposal (submitted 5-99). Funding, as a supplemental selection, has been provided by NASA with reduced scope from that originally proposed.

17. Key Words (Suggested by Author(s) Dynamics, Control, Analysis, Simulation, Space Solar Power, Flexibility, Structures, Treetops, Nastran, Multi-body, Modeling		18. Distribution Statement NASA/MSFC Attn: Dr. Connie Carrington Marshall Space Flight Center, AL 35812	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this Page) Unclassified	21. No. of pages 301	22. Price